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WAR DEPARTMENT

TECHNICAL MANUAL

PARACHUTES, AIRCRAFT FABRICS, AND CLOTHING

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TECHNICAL MANUAL
No. 1–440

WAR DEPARTMENT,
WASHINGTON, *January 10, 1941.*

PARACHUTES, AIRCRAFT FABRICS, AND CLOTHING

Prepared under direction of the
Chief of the Air Corps

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SECTION I

MATERIALS

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1. Definition of terms.—The following terms are commonly used in the description of textiles:

a. Fibre.—The basic substance from which the textile is made, that is, flax, cotton, silk, etc.

b. Staple.—Commonly used in stating the character and quality of fibres. Long staple cotton is raw cotton, the fibres of which are at least 1½ inches long.

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c. Selvage edge.—The edge of cloth which is woven so as to prevent raveling (fig. 1).

d. Warp.—The threads which run lengthwise of the cloth as it comes from the loom (fig. 1).

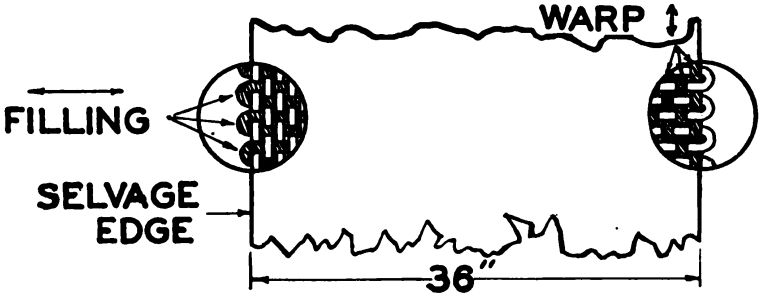

FIGURE 1.—Warp and filling threads.

e. Filling.—The threads which run crosswise of the cloth as it comes from the loom (fig. 1).

f. Mercerize.—To treat a fabric with a chemical to cause it to shrink and become stronger. The process gives a silky luster to the fabric.

g. Calender.—To press fabric between rollers to make it smooth. Airplane fabric which has been calendered has been washed and ironed.

h. Bleaching.—A chemical process to whiten cloth or thread.

i. Thread.—A very thin line or cord of flax, cotton, silk, or other fibrous substance twisted and drawn out.

j. Cord.—A string or small rope of several threads twisted or woven together.

k. Combed.—This process disentangles and collects together all the long fibres, while the short staples are combed away.

l. Carded.—The process of carding disentangles and collects together all the fibres regardless of length.

m. Spun silk.—A cheap yarn made from floss silk, carded and spun. Spun silk is often mixed with cotton.

n. Worsted.—Made from a smooth-surfaced yarn spun from long stapled pure wool, combed so that its fibres lie parallel to each other.

o. Electrified sheep shearing.—The wool fibre has a lustre and is sheared to a finish commercially known as electrified or beaverized, in which the raised fibres are laid in one direction.

p. Twist of thread or cord.—Thread and cord are made in both right and left twist. The direction of the twist may be determined by holding the thread as shown in figure 2 and turning it between the thumb and forefinger of the right hand. If the thread unwinds

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when turning it to the left, it is right twist; if it tightens, it is left twist.

q. Serving.—Covering a splice by wrapping a thread continuously and tightly around it.

2. Cloth.—Clothing and aircraft cloth commonly used for the maintenance of equipment consists of—

a. Fabric, mercerized cotton, airplane.—Used for the repair and lining of summer helmets and jackets; manufacture of tow targets, wind direction indicators, danger cones; and covering of airplane surfaces. It is highly resistant to tearing.

b. Cloth, cotton, light weight, khaki, mercerized.—Used for the manufacture and maintenance of summer flying garments.

c. Cloth, gabardine.—Used for the maintenance and repair of the outershell of summer helmets.

d. Bunting, cotton.—Used for landing field flags or markers and pitot static head (tube) streamers.

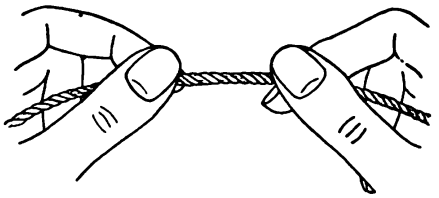

FIGURE 2.—Twist of thread or cord.

e. Silk, parachute.—Used for the manufacturing and maintenance of parachute canopies, pilot parachutes, and scarfs.

3. Duck.—The different types of duck used are—

a. Duck, cotton, olive drab, 12-ounce, without waterproofing.—Used for the maintenance and manufacture of luggage compartments, boots, cockpit covers, engine covers, crash pads, aerial delivery units, map cases, chafing patches, parachute packs, flyers kit bags, etc.

b. Duck, cotton, olive drab, medium texture, 22.33-ounce, without waterproofing.—Used for bomb bay curtains, parachute dummy covers, flyers clothing bags, etc.

c. Duck, cotton, rubberized.—Used for packing cases, covers, etc.

4. Tape.—The different types of tape are—

a. Serving tape.—Tapes, cotton, serving, ¾-inch and 1⅛ inches wide, are plain weave tapes with smooth selvage edges. The 1⅛-inch width is used for reinforcing the edges where grommets, eyelets, and hooks are set, while the ¾-inch width is used for binding ragged edges of covers and panels, and for wrapping metal airplane structures to which fabric covering is to be pinned or sewed.

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b. Adhesive tape.—(1) Tape, adhesive, zinc oxide, 1 inch wide, is used as a reinforcement (to prevent cutting) when splicing cord, rope, or the rubber vent ring used in the puckered vent of the canopy of parachutes before serving. This material is also used to cover the edges of metal or hard vulcanized rubber sheet, before machine sewing it to webbing, fabric, or duck.

(2) Hand or machine sewing cannot be done through this tape as it gums the needle. The zinc oxide coating permits adhesion to any material without further attachment.

c. Reinforcing tape.—Tape, cotton, ¼ to 1 inch wide, is a special tape used between the lacing cord and the fabric covering over wing ribs, to prevent the cord from cutting or wearing through the fabric. The 1-inch width is also used for attaching the name tabs on clothing bags and for reinforcing inspection openings.

5. Webbing.—The different types of webbing are—

a. Cotton, natural, light weight, 1, 1⅛, 1¼, and 1½ inches wide.—Used for reinforcing parachute packs and large covers where grommets, eyelets, hooks, etc., are attached.

b. Cotton, natural, medium weight, 5 inches wide.—Used for belts, straps, etc.

c. Linen, natural, 1¾ inch, type F. 1,200 pounds T. S. and 1¾ inch, type H, 3,000 pounds T. S.—Type F webbing is used for reinforcing parachute packs, large covers, bomb hoists, slings, etc.; type H, for parachute harness and is identified by a black or blue thread marker in the center.

d. Linen, olive drab, 9/16 and 1¼ inches wide.—The 1¼ inch webbing is used for parachute pack side and end tabs, and for reinforcing wind cones, bags, and covers; the 9/16 inch size, for pneumatic back pads.

e. Elastic, ⅞ inch wide.—Used for goggle headbands, face mask bands, etc.

f. Elastic, 1½ inch wide by ⅛ inch thick.—Used for winter flying trouser suspenders.

6. Thread.—The terms "machine," "machine twist," and "left twist" appearing in the thread nomenclature indicates a "left twist thread." The shuttle and rotary hook of sewing machines will unwind a right twist thread, causing thread breakage and weak seams. The different types of thread used are—

a. Machine.—(1) The thread used for all machine sewing in the manufacture and repair of winter flying clothing, sheep shearling, and seal brown leather cape is silk, machine twist, size E, dark brown. The size E, white silk thread, is used for sewing parachute canopies, etc.

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(2) Thread, cotton, machine, silk finish, natural and olive drab, number 16, 4 cord, is used for machine sewing all covers, etc., manufactured of 12-ounce duck, the fabrication and lining of fabric flying equipment and clothing, and the sewing of all airplane covers.

(3) Thread, cotton, machine, silk finish, black, number 16, 4 cord, is used for machine sewing of artificial and horsehide leather for upholstering, etc.

(4) Thread, linen, left twist, 5 ply, is used for machine sewing of safety belts and parachute harness.

b. Hand sewing.—(1) The thread used for hand sewing of repairs on flying clothing, manufactured from cape leather and sheep shearling, in size E, brown silk thread.

(2) Thread, cotton, heavy, silk finish, number 8, 4 cord, is used for hand sewing and basting before machine sewing covers made of duck, felt, cloth, or airplane fabric.

(3) Thread, linen, left twist, number 16, 3 cord, is used for hand sewing eyes and cones on parachute packs, stitching rip-cord grip pockets, break stitching riser webs, permanent hand stitching of harness, stitching housing to pack and harness, and stitching tab to pack carrier assembly.

7. Cord.—The different types of cords used are—

a. Cotton, braided, 1/8-inch diameter.—Used for lacing belts and gun camera covers.

b. Cotton, braided, sash.—Size 6, 3/16-inch diameter cord is used for lacing small engine covers, etc.; size 8, 1/4-inch diameter cord, for lacing large engine and cockpit covers; and size 10, 5/16-inch diameter cord, for towing targets. Size 12, 3/8-inch diameter cord may be used as a substitute for size 10.

c. Cotton, braided, special, lacing.—Used for lacing the fabric to wing ribs to prevent the fabric from being torn away in flight, and to make it follow closely the shape of the rib. It is also used to lace the covering of some fuselages to former strips and ribs. The cord has a high resistance to fraying by being braided and waxed.

d. Linen, waxed, 3 to 9 cord.—Used for machine and hand sewing of medium and heavy leathers, securing chafing strips, sewing belting, and serving rope. The 9 cord is also used for lacing upholstering buttons on life preserver cushions.

e. Silk, braided.—This cord is manufactured in three sizes and used as follows: 100 pound T. S. cord, for pilot parachute suspension lines; 325 pound T. S. cord, to tie seat cushions to parachute packs and cord; and 450 pound T. S. cord, for parachute canopy suspension lines.

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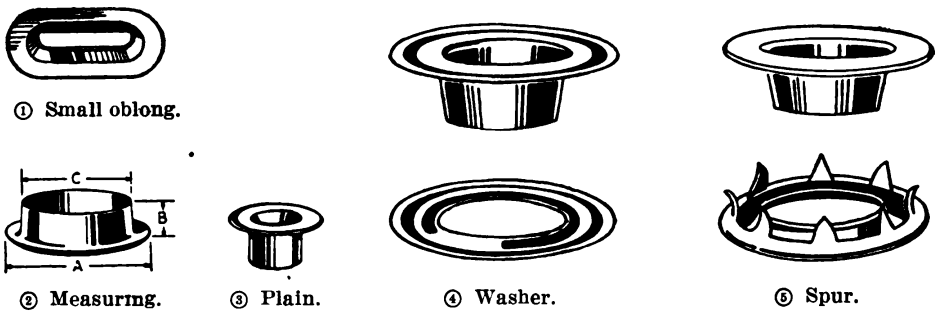
f. Linen, shock absorber, serving.—This cord has a hard glazed braided surface with a high resistance to fraying and a high tensile strength. It is used for lacing covers and binding, and serving the ends of rubber shock absorber cord. Numbers 16, 20, 24, and 28 linen blocking cord may also be used for this purpose, if a larger cord with more tensile strength is required.

8. Storage of textiles.—Textiles such as cordage, fabric, and leather must be properly treated and stored when not in use. It is important that they be protected from the deteriorating effect of weather, heat, direct sunlight, moisture, and the destructive effects of vermin. They should be handled as little as possible before cutting or using. Prolonged exposure to direct sunlight or moisture is very detrimental to textiles, as such materials will absorb moisture which will cause loss in tensile strength. Where it is necessary to maintain a small quantity of textiles for frequent use, they may be stored in a well sealed locker, closet, or other small enclosure of suitable size. The floor, shelves, etc., of such containers should be kept well sprinkled with naphthalene flakes, or the flakes may be kept in small cloth bags around or between the layers of textiles.

9. Hardware.—The following hardware is used in connection with fabric work:

a. Grommets.—Grommets, plain, oblong or spur, aluminum or brass, with washers, numbers 00$\frac{5}{32}$ inch, 0$\frac{1}{4}$ inch, 1$\frac{5}{16}$ inch, 2$\frac{3}{8}$ inch, 3$\frac{7}{16}$ inch, 4$\frac{1}{2}$ inch, and 5$\frac{5}{8}$ inch (fig. 3), are used where it is necessary to have holes through covers, bags, panels, and upholstering as a reinforcement for lacing, etc. The grommets are set with suitable dies in either a hand or foot operated press made especially for this purpose. The size of grommets and eyelets is measured as shown in figure 3 ②.

b. Eyelets.—Eyelets, lacing, $\frac{1}{8}$, $\frac{3}{16}$, $\frac{1}{4}$, and $\frac{5}{16}$ inch I. D., differ from grommets in that no washer is used under the crimp; they are smaller in outside diameter and are black enameled. The fact that no washer



① Small oblong. ② Measuring. ③ Plain. ④ Washer. ⑤ Spur.

FIGURE 3.—Eyelets and grommets.

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is used makes them thinner and more desirable for lacing small covers, upholstering, and clothing. However, they are not as strong as grommets, will pull out of the material easier, and should not be used in the place of grommets where the latter are specified.

c. Hooks.—Hooks, lacing, brass, 9/32, 3/8, and 7/16 inch, are frequently used for lacing winter flying clothing or openings on covers where it is impossible to lace through the panel or object.

d. Tacks.—Tacks, carpet, blued, number 6 by ½ inch, are used for holding one or more thickness of material such as leather, duck, or cloth in place on the cutting table when trimming.

e. Rivets.—Rivets, copper, belt, number 11 by ½ to 7/8 inch and number 13 by 3/8 to 3/4 inch, are used for reinforcing belting or corners of covers, etc., where considerable strain may exist. The rivets are supplied with copper washers and are set with a rivet set. Numbers 11 and 13 rivet sets are used for this purpose.

f. Interlocking fastener.—Interlocking fasteners are used in the manufacture of baggage compartments, blind flying cockpit hoods,

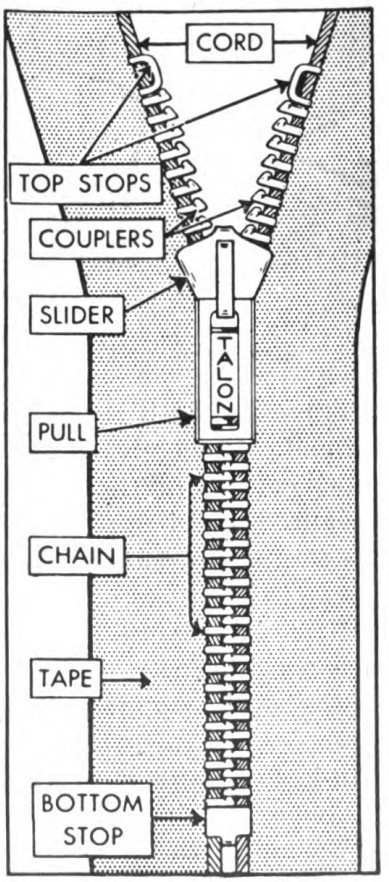

FIGURE 4.—Interlocking fastener.

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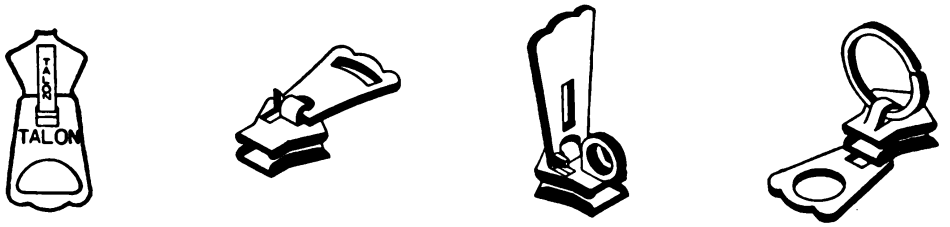
inspection openings for wings and fuselage, fabric covers, and cockpit covers. A completely assembled fastener is shown in figure 4. The number 5 and 6 fasteners consist of cotton tape and nickel-silver scoops attached to a cord assembly. The strips are obtainable from stock in 72-inch lengths. The number 5 size is the smallest standard fastener. It has a comparatively thin tape and small chain of scoops. The number 6 size is the heavy duty type. It has a comparatively large chain of scoops and thick tape.

(1) The slider and pull are the parts which engage and disengage the two strips of scoops in closing and opening the fastener. The various types are shown in figure 5. The standard nonlock type (fig. 5 ①) is used for closed bottom fasteners on panels, covers, bags, etc. The pin-lock slider (fig. 5 ②) is used for separating fasteners on clothing such as jackets, trousers, vests, etc. This slider will lock any place along the chain of scoops when the pull tab is down against the slider. The padlock slider (fig. 5 ③) is used on flyers' clothing bags. The double-pull slider (fig. 5 ④) is used when it is necessary to open a cover from both sides, such as on blind flying cockpit hoods and bomb-bay curtains.



① Standard nonlock. ② Pin-lock. ③ Padlock. ④ Double-pull.

FIGURE 5.—Sliders for interlocking fasteners.

(2) The bottom stop is used when it is not necessary to disengage the strips at the bottom end. It merely serves as a stop to prevent the slider from being pulled entirely off the scoops.

(3) The top stop is required on the upper end of each of the strips of scoops. It serves as a stop to prevent the slider from being pulled off.

(4) The separating bottom stop is used at the bottom ends of the strips of scoops when it is necessary that the two strips be completely disengaged. In this case the bottom stop is not used and the separating stop installed in its place.

(5) Special interlocking fasteners are occasionally required on articles such as cockpit hoods, baggage compartments, etc. When these are required the drawings of the article should be consulted for part numbers and installation instructions.

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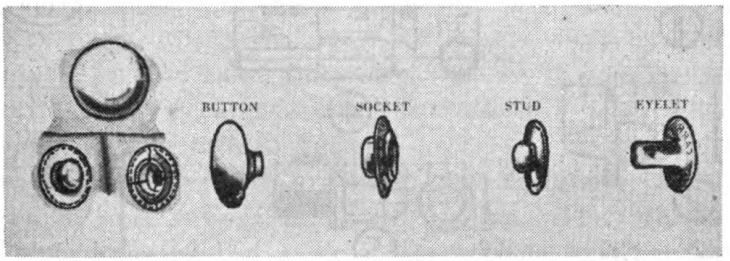
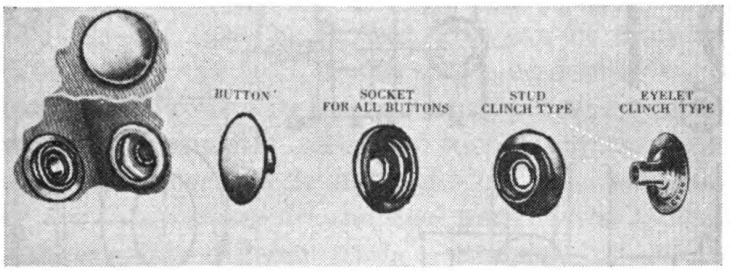
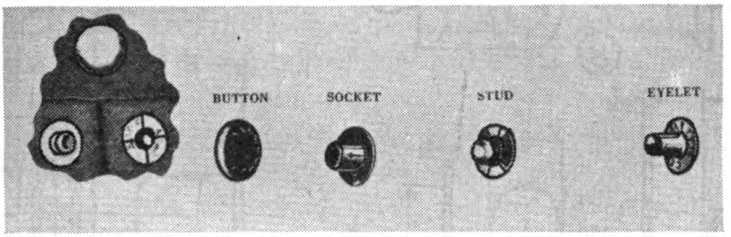
g. Glove fasteners.—Glove fasteners are used in the manufacture of clothing, engine and cockpit covers, blind flying cockpit hoods, luggage compartments, etc. They are furnished in four parts and the trade names of the types illustrated are "Anzo Dot" (fig. 6 ①) "Durable Dot" (fig. 6 ②), and "Segma Dot" (fig. 6 ③).



① Anzo Dot.



② Durable Dot.



③ Segma Dot.

FIGURE 6.—Glove fasteners.

h. Lift-the-dot fasteners.—This type of fastener locks securely on three of its four sides, yet it may be opened easily by simply lifting the side with the "Dot." The locking feature of the "Lift-the-Dot" fastener gives a degree of security found in no other fastener. The construction of the short prong socket is such that it will resist abnormal strains in the thinnest material. The long prong socket is designed for use only on extra thick material and should not be used on thin material except as a substitute, in which case, the prongs can be cut shorter just before crimping. The terms "single," "double," and "triple" refer to the lengths of the stud or prong.

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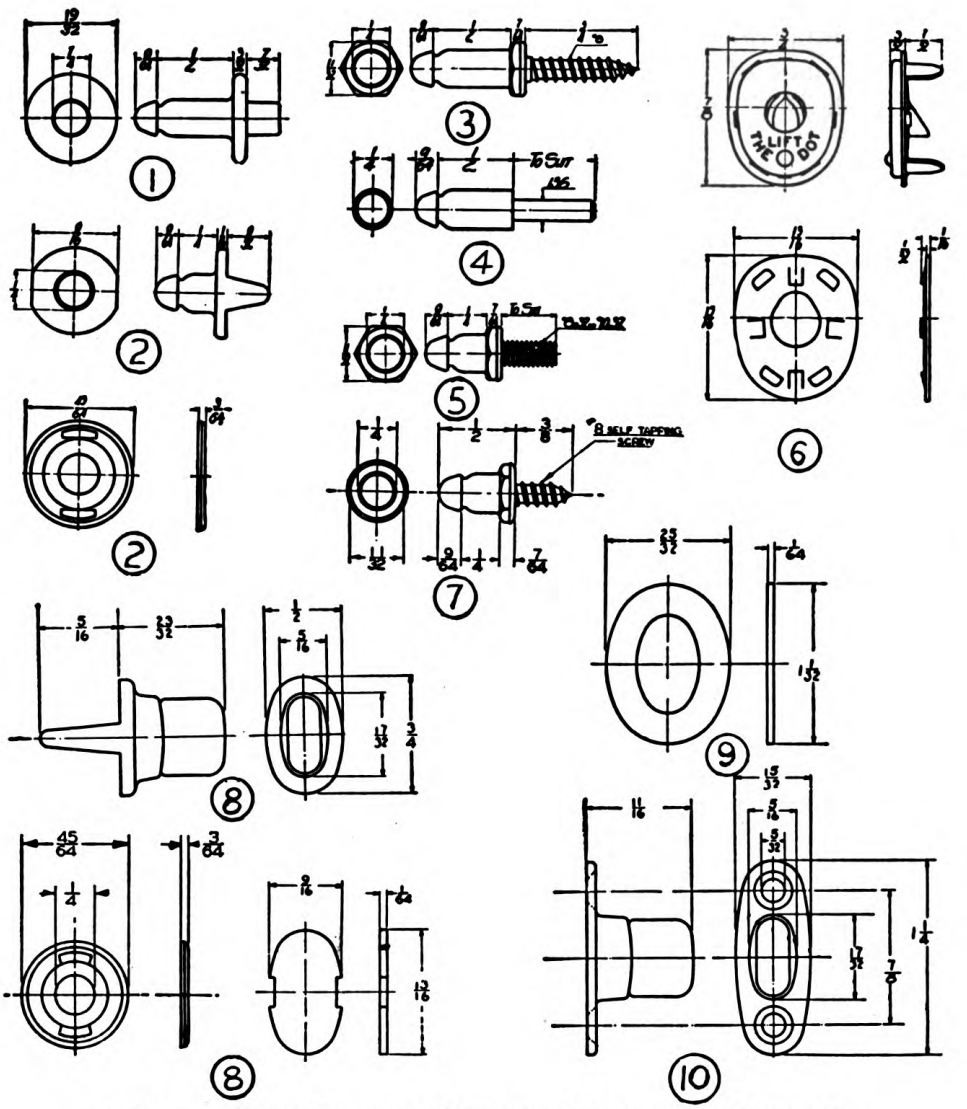

1. Fastener, lift-the-dot, post and washer, tubular base, double curtain.
2. Fastener, lift-the-dot, post and washer, clinch base, single curtain.
3. Fastener, lift-the-dot, wood screw base, single curtain (hex base).
4. Fastener, lift-the-dot, post, rivet base, double curtain.
5. Fastener, lift-the-dot, post, machine screw base, single curtain.
6. Fastener, lift-the-dot, socket and washer (clinch plate), long and short prong.
7. Fastener, lift-the-dot, post, sheet metal base, single curtain.
8. Fastener, turn knob clinch type, with two types of washers.
9. Eyelet, turn knob type.
10. Fastener, turn knob type.

FIGURE 7.—Lift-the-dot and turn knob fasteners.

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Single length is used where there is only one socket on the stud, or two or three thicknesses of material for the prong. Double length is longer than the single length so as to take care of two sockets on the stud, or four or five thicknesses of material for the prong. Triple length is still longer than the double length so as to take care of three sockets, as in the case of two or three overlapping panels. (These terms also apply to "Turn knob" fasteners.) Fasteners of this type are for the same purpose as glove fasteners, except that they are used where greater strength is required. They are furnished in several styles as shown in figure 7.

i. Fastener, turn knob.—Turn knob type fasteners (fig. 7) consist of four parts; knob, eyelet, and two washers. They are used in the manufacture of engine and cockpit covers, blind flying cockpit hoods, luggage compartments, hand bags, etc. They have an advantage over the lift-the-dot fastener in that they can be more readily released. The fastener or stud can be single or double length to take care of one or two eyelets in the case of overlapping material.

j. Pins.—It is frequently necessary to pin covers, clothing, etc., temporarily while machine or hand sewing is accomplished. Two types used for this purpose are the steel pin and the T-head pin.

10. Leather.—The different leathers used are—

a. Lacing, rawhide, 1/8 and 1/4 inch wide.—Used for lacing upholstering around cockpits, crash pads, etc., to cowlings. Rawhide is not used for any wrapping or reinforcement on aluminum as it corrodes the metal.

b. Leather, strap, russet, 1/32 and 1/16 inch thick.—Used in the modification of flying clothing.

c. Shearling, sheep, electrified, 3/8, 5/8, 3/4, and 1 inch pile lengths.—Used for fabrication and maintenance of winter flying garments and winter mechanics' suits.

d. Leather, artificial, upholstering.—Used for blind flying cockpit hoods, back rests, crash pads, head rests, and padding around cockpits.

e. Leather, cape, seal brown.—Used for the manufacture and repair of flying helmets, jackets, miscellaneous flying clothing, etc.

f. Leather, chamois skin.—Used for lining oxygen face masks, helmets, chin straps, etc.

g. Leather, horsehide.—Used for flying clothing, head rests, crash pads, and upholstering, where heavy wear and tear occurs.

h. Leather, kid.—Used for insignia on flying garments.

i. Gimp, artificial leather.—Used to cover the raw edges of artificial leather and upholstering tacks for panel upholstering work and is applied by glue, sewing, or tacking.

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j. Belting, leather, round.—Used for belting on sewing machines, etc.

k. Belting, leather, flat.—Used for belting on sewing machines, etc.

11. Upholstering material.—Most upholstering is done with artificial or horsehide leather. Upholstering on airplanes consists mostly of blind flying cockpit hoods, back rests, crash pads, head rests, life preserver cushions, and padding around cockpits. The materials used are—

a. Kapok, fibre.—Used for padding life preserver cushions, vests, helmet chin straps, and delivery units. It is a light, silky fibre, which has great buoyancy in water.

b. Hair, curled, upholstering.—Used for stuffing pads, head rests, and the upholstering around cockpits.

c. Button, upholstering, 9/16 inch.—Used on life preserver cushions during the process of upholstering.

d. Felt, pressed, gray, 3/16, 1/4, 3/8, and 1/2 inch thick.—Used for padding purposes in upholstering.

e. Packing, rubber, sheet, 1/16 to 1 inch thick.—Used for padding when upholstering.

12. Miscellaneous materials.—*a. Beeswax.*—In order to prevent thread from fraying and untwisting during the sewing operation, beeswax is applied to the hand sewing thread. Only pure beeswax should be used for this purpose. Impurities in other waxes may cause oil or grease spots after being used.

b. Wax, paraffin.—This wax is used to prevent fraying of the ends of webbing and edges of cloth. An ordinary electrically heated glue pot may be used for melting the wax preparatory to use. The water compartment of the glue pot, when in use, should be kept at least three-fourths full. About one-fourth to three-eighths inch of the edges of the material are dipped into the wax after it has been heated enough to flow freely.

c. Talc, powdered, tire (soapstone).—This may be sprinkled over the area of covers to assist in slipping them over objects. External surfaces of the rubberized fabric of pneumatic rafts are thoroughly powdered with talc before folding.

d. Plastic sheet, transparent, cellulose, acetate base.—This is sometimes used as a stiffener in small leather or duck bags and also for transparent identification tags.

e. Aluminum alloy.—This material is used as a stiffener where strength is required on large bags, such as flyers' clothing bags.

f. Cheese cloth.—This cloth is used for applying and polishing wax.

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SECTION II

SHOP EQUIPMENT AND TOOLS

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13. Cleanliness of shop.—*a.* The shop in which clothing, parachutes, etc., are stored and repaired must be clean and well ventilated. If the relative humidity is too high or too low, deterioration of material may result. There is no work in which cleanliness is of more importance than in the clothing shop. Oily or paint soaked rags, waste, trash, and other matter which might be the cause of spontaneous combustion, if not otherwise disposed of immediately after use, should be placed in tightly covered metal receptacles and emptied at least once a day prior to closing the building.

b. Fabrics treated with paint containing waterproofing compound are subject to spontaneous combustion if improperly stored before the paint has thoroughly dried, and fires from this source have occurred. Therefore, to avoid fire hazards, no fabric articles should be packed, stored, or shipped after painting, or left in shops or other buildings for the paint to dry. Such articles should be painted locally only at the time they are actually required for installation, or whenever necessary thereafter, and must be thoroughly dried in the open air.

14. Temperature of shop.—It is essential that careful attention is given to the ventilation and heating of the clothing and parachute shop so that the temperature and humidity can be controlled. This will give additional protection to the parachutes, clothing, and textile materials from the extremes of temperature and moisture. The ideal condition is a temperature of 75° F., and humidity not over 65 percent, as measured on a wet and dry bulb hygrometer.

15. Hand tools.—*a.* The hand tools required for the average clothing and parachute shop are shown in figure 8 and their specific uses are as follows:

(1) Awl, round, noncutting, 8-inch (10), is used for punching holes for the needle when hand sewing thick materials such as leather, felt, etc.

(2) Hammer, tack, magnetic, 4-ounce (18), is used for driving tacks or small nails. One side of the head is magnetized for holding

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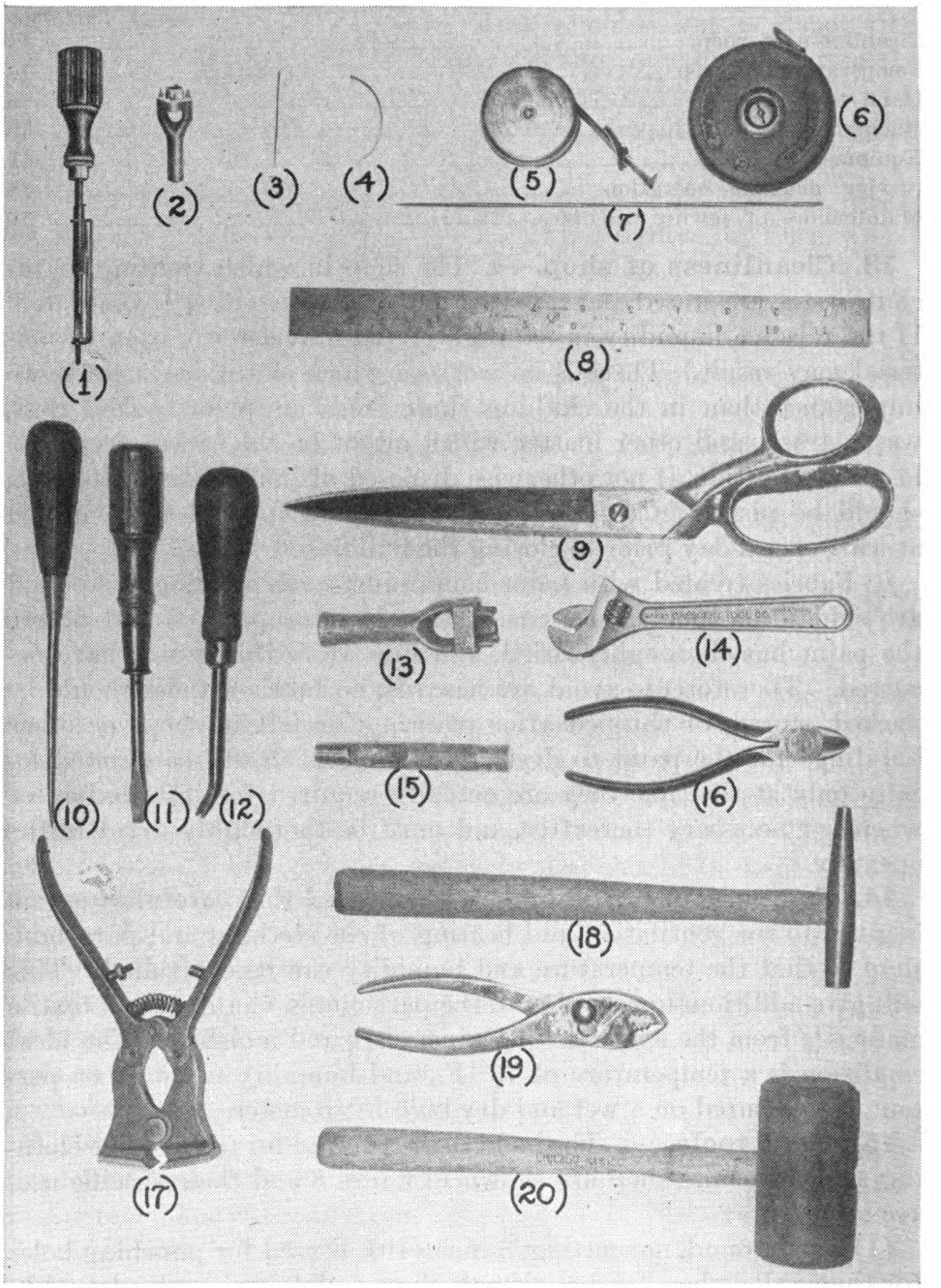

FIGURE 8.—Hand tools.

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a tack or small nail while it is being started, the other side is used to finish driving it. Experienced workers hold the tacks or nails in their mouth and remove them by the magnetized side of the hammer one by one as needed.

(3) Mallet, rawhide, 2-inch face (20), is used as a hammer for driving leather punches, etc.

(4) Needles, upholsterer's, curved, 2½-inch-17 gage, 4-inch-17 gage, and 8-inch-14 gage (4), are used for hand sewing.

(5) Needles, sewing, hand number 1 to 7 (3), are used for hand sewing or basting before machine sewing.

(6) Needles, upholsterer's, straight, single end, extra light, 8 to 12 inches (7), are used for lacing upholstering buttons and miscellaneous hand sewing, and lacing of thick materials.

(7) Nippers, end cutting, compound, adjustable jaw, 7 inch (17), are used for removing the scoops on short strips of interlocking fasteners.

(8) Pliers, combination, slip joint, 6 or 8 inches (19), are used for attaching the top and bottom stops on interlocking fasteners.

(9) Pliers, diagonal cutting, 6 inch (16), are used for miscellaneous cutting.

(10) Puller, tack, claw (12), is used for removing tacks and small nails.

(11) Punch, cutting, leather, single bow, ⅛ to 1½ inch (15), is used for punching round holes in leather, duck and fabric for grommets, eyelets, hooks, and glove fasteners.

(12) Punch, (Carr fastener) socket, hand, number 151 (13), is used for punching the holes for "lift-the-dot" fastener sockets.

(13) Punch, eyelet, oval, ½ by $^{11}/_{16}$ inch (2), is used for punching the holes for eyelet and turn knob fasteners.

(14) Rule, steel, spring, tempered, 12 inch (8), is used for layout and measuring purposes.

(15) Shears, trimmers, bent handle, 10 to 12 inch (9), are used for cutting leather, duck, fabric, etc.

(16) Screwdrivers, common, 3 and 6 inch blade (11), are used for general repair work.

(17) Screwdrivers, clock, with screw holding attachment (1), are used for the same purpose as the common screwdriver.

(18) Tape, measuring, steel, 25 or 50 feet (6), is used for measuring and laying out articles.

(19) Tape, rule, extension, 72 inches long (5), is used for the same purpose as the measuring tape.

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(20) Wrench, adjustable jaw, single end, 6 inch (14), is used for repair work.

b. In addition to those listed in *a* above, the following tools will be used occasionally:

(1) Square, carpenter's, is used for laying out square corners.

(2) Plane, block, adjustable, 6 inch, is used for tapering leather straps or leather belting before machine sewing.

(3) Compass, pencil, capacity of 5 inches or more in radius, is used for laying out radii in the manufacture of bags, covers, etc.

(4) Palm, sewing, number 2, or palm, sailmakers, seaming, is used while hand sewing difficult thick materials.

c. The tools shown in figure 9 are usually made locally and are required for special, detailed operations. They are—

(1) Creaser, leather (1), is used for creasing the edges of straps or belting for a more finished edge.

(2) Knife (2) can be made from a hacksaw blade and is used for cutting or ripping machine seams in the repair of clothing, etc.

(3) Stuffer, upholstering (3), is used for stuffing upholstering with upholstering hair or kapok fibre.

(4) Spoon, upholstering (4), is used for smoothing the inside of upholstering after using the stuffer.

(5) Tool, parachute folding (5), is used for folding the panels of the parachute canopy.

16. Machines.—A brief description and the purpose of the principal machines required in the parachute and clothing shop follow:

a. Sewing machines.—Where considerable leather, duck, and fabric work is done, several types of sewing machines are needed. The motor driven, lock and chain stitch types are commonly used, therefore, instructions in this manual will be based on these machines.

(1) Machine, number 111W100, is a one-needle machine which is well adapted for sewing light weight material, such as airplane fabric and silk, or heavy duck and rubberized materials. It has a belt driven rotary hook and is equipped with both the needle feed and drop feed, which is of particular advantage for sewing two or more plies of material when it is necessary that they come out even at the end of the seam. It is very similar in appearance to machine number 111W112 (fig. 10).

(2) Machine, number 111W112 (fig. 10), is equipped with a compound feed (needle feed and drop feed) and alternating pressers, which especially adapt it for stitching duck, leather, upholstery, and clothing made from sheep shearing, etc. It has one needle and a belt driven rotary hook.

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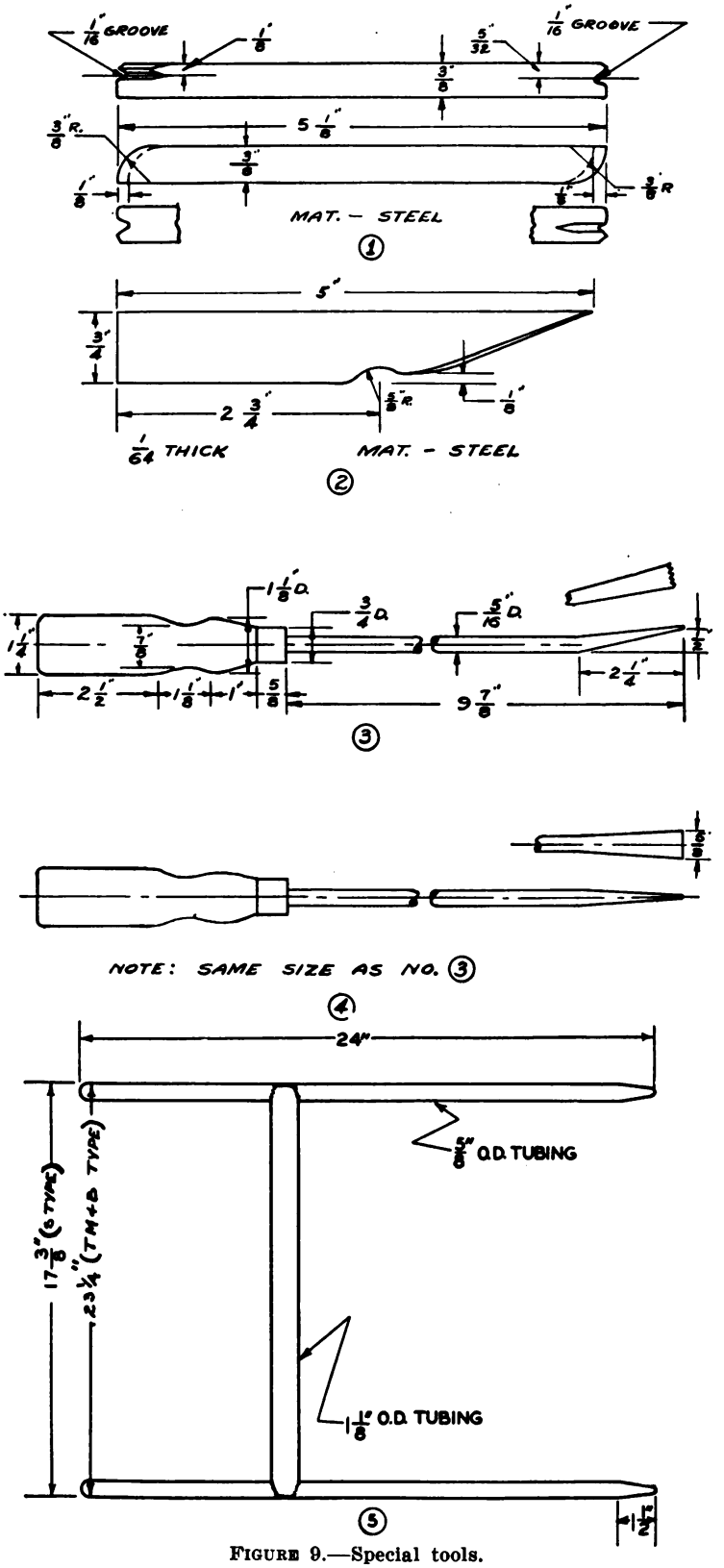

FIGURE 9.—Special tools.

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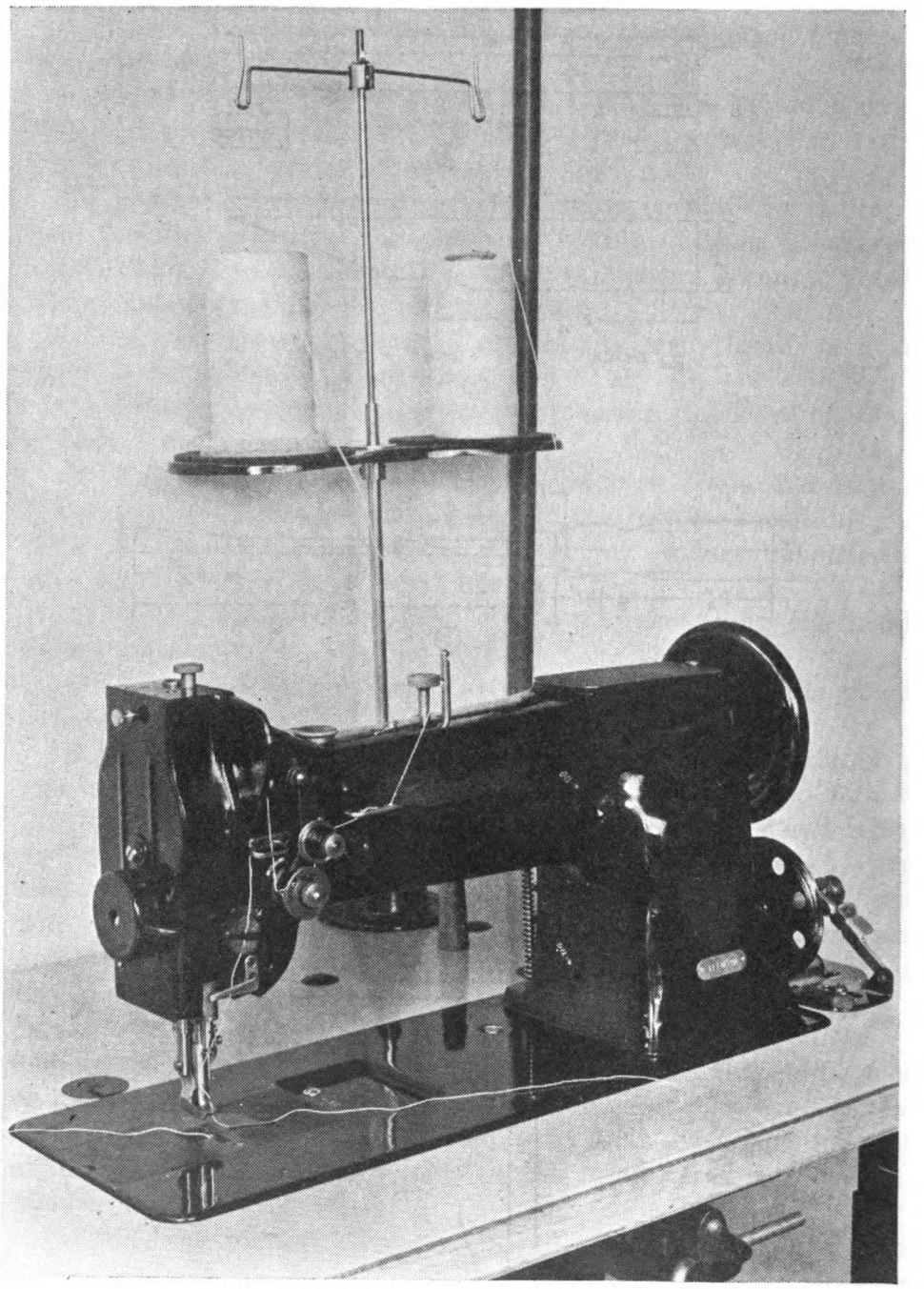

FIGURE 10.—Sewing machine, type 111W112.

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(3) Machine, number 112W116 (fig. 11), is a two-needle machine which is used for sewing strips of fabric and duck together in the manufacture of large panels or covers. The needles may be ⅛ inch or more apart. It is equipped with two belt-driven rotary hooks and has a compound and puller feed. It is particularly suited for sewing heavy bulky materials.

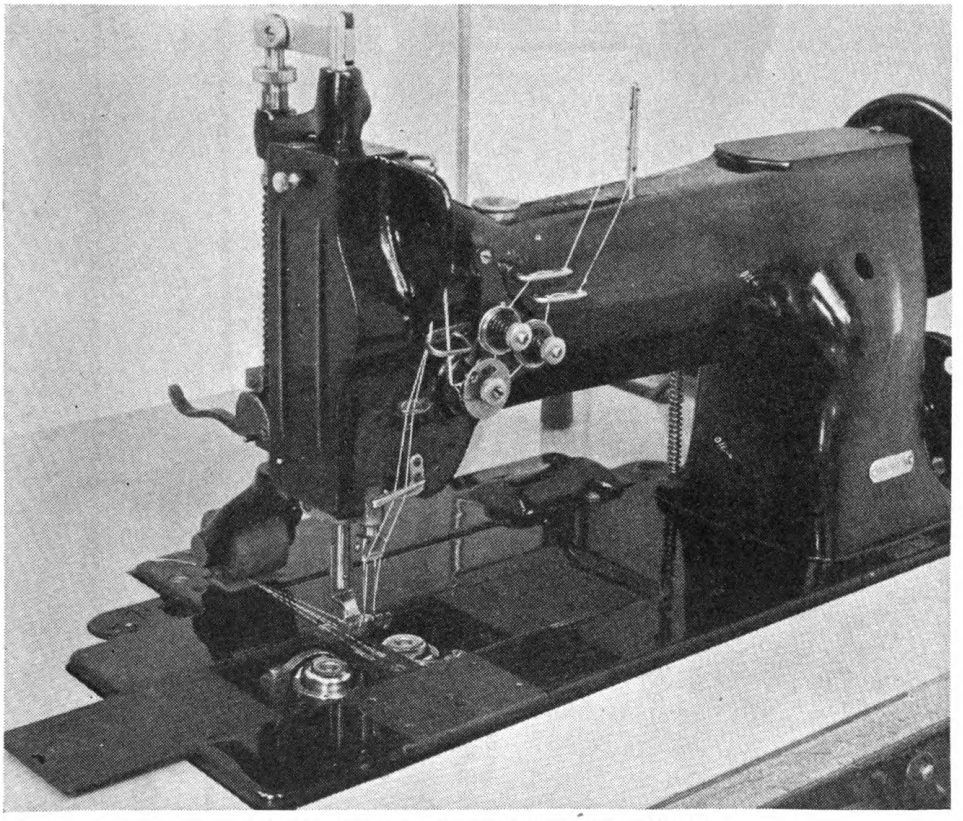

FIGURE 11.—Sewing machine, type 112W116.

(4) Machine, 97–10 (fig. 12), is designed for general use in the fabrication and maintenance of parachute harness, and is particularly suitable for stitching two or more plies of heavy materials. It has one needle and one oscillating shuttle. The design of the machine is such that round objects can be sewn and, when it is in operation, it differs from the machines described in (1), (2), and (3) above in that the operator stands instead of sits. It is equipped with needle feed only.

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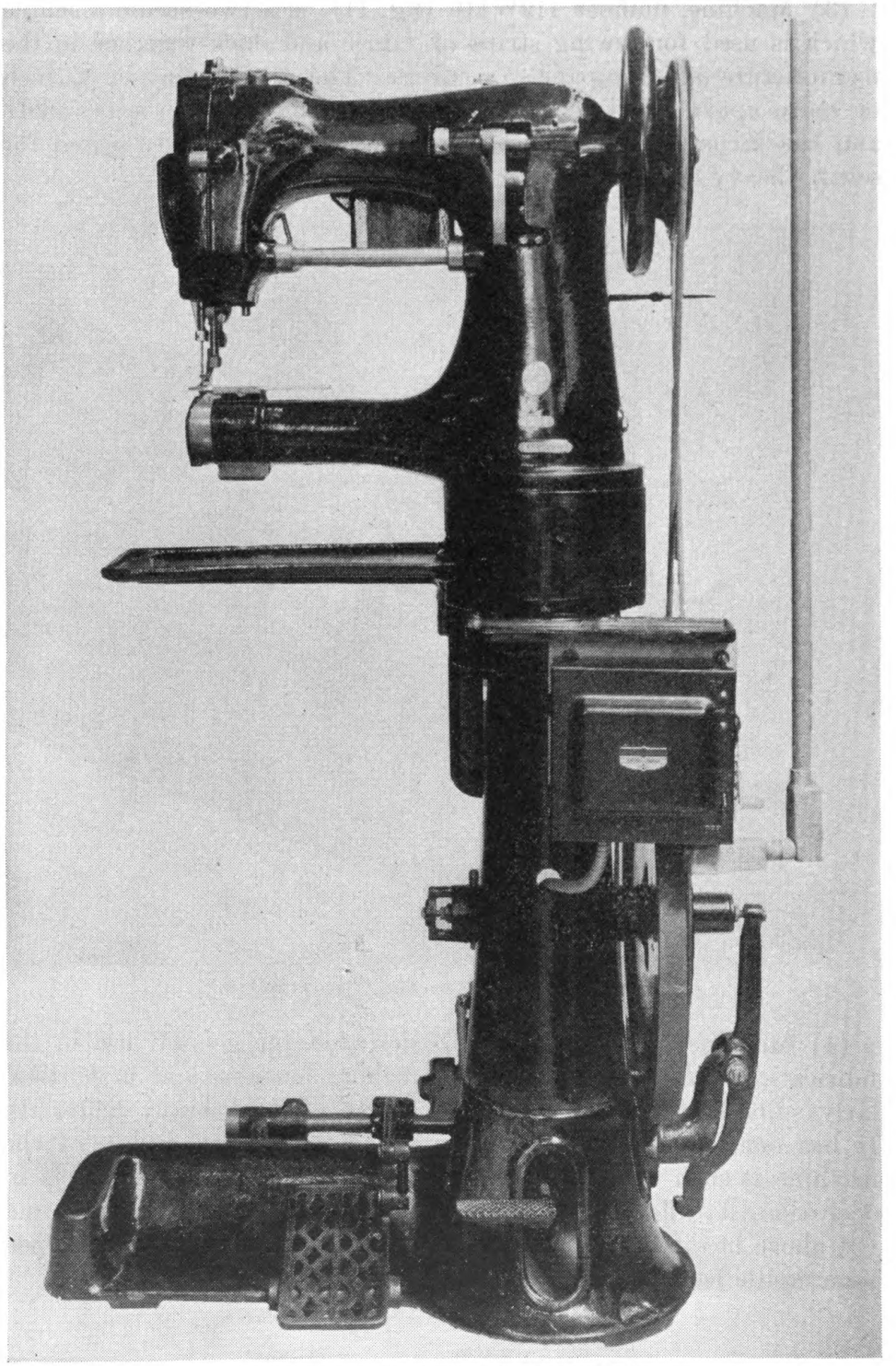

FIGURE 12.—Sewing machine, type 97-10.

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(5) Machine, number 176–22 (fig. 13), is used only for sewing clothing fabricated from sheep shearling. It makes a firm, overcast seam, and differs from the other machines in that it has no bobbin, causing it to make a single thread chain stitch.

b. Stencil cutting machine.—The stencil cutting machine (fig. 14) is used for cutting stencils for the markings required on parachutes, etc. Two sizes are required for these stencils, ½-inch and 1-inch letter size.

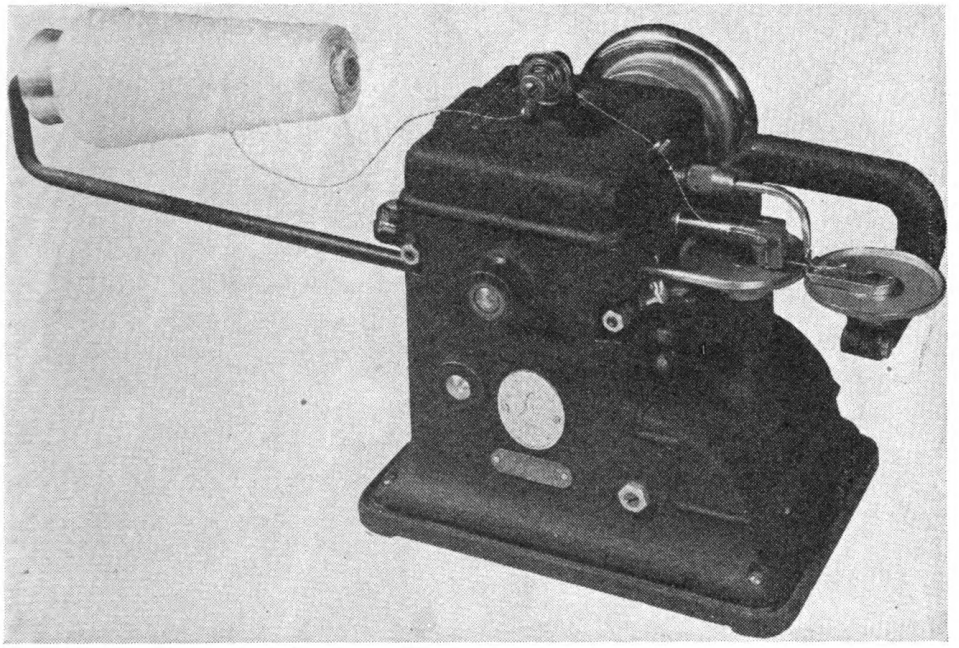

FIGURE 13.—Sewing machine, type 176–22.

c. Press, lead, seal, parachute inspectors.—This machine is used for compressing the lead seal over the knot of the cotton sealing cord after the parachute has been packed and inspected. Each of these presses has a number assigned and is issued only to authorized parachute personnel.

d. Grommet and eyelet setting machine.—Grommet and eyelet setting machines are furnished in two types: a foot-operated machine and a hand machine (fig. 15). An assortment of sets of chucks and dies are required for use in these machines for setting the various sizes of grommets, eyelets, and hooks. A set consists of two dies

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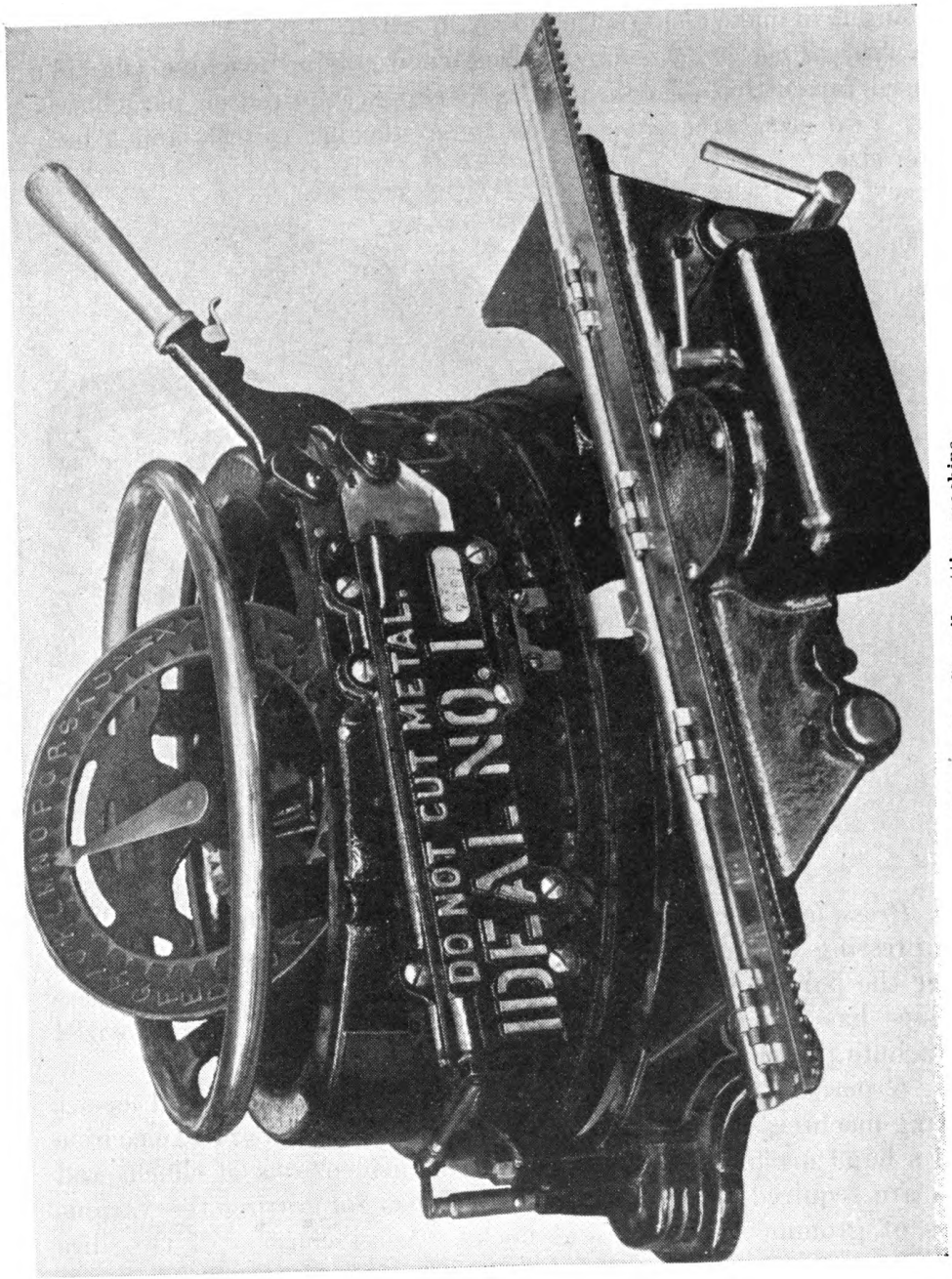

FIGURE 14.—Stencil cutting machine.

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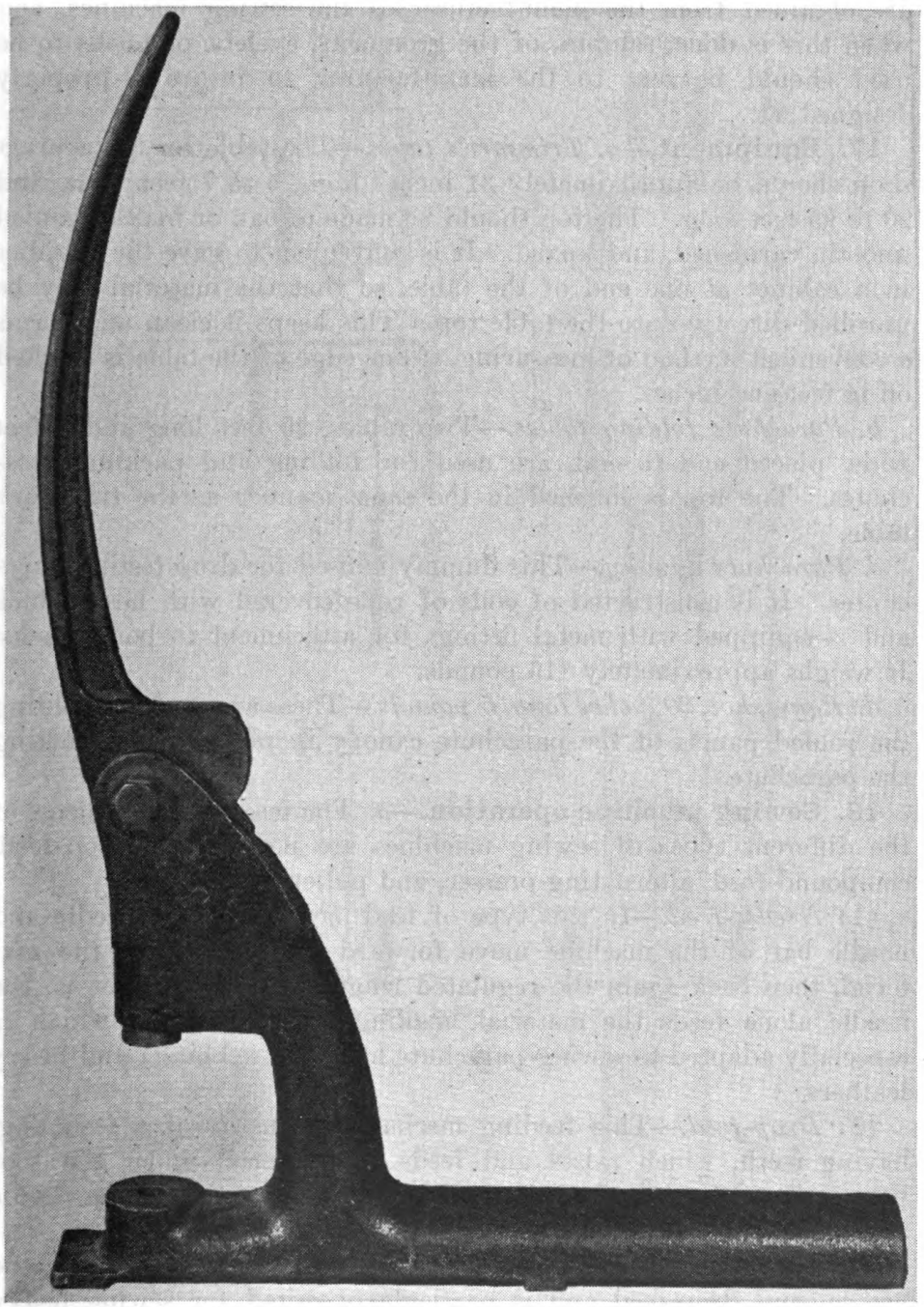

FIGURE 15.—Grommet and eyelet setting machine.

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(one lower and one upper part) (fig 16), and is required for each of the different sizes of grommets, eyelets, and hooks. The sets are obtained from the manufacturer of the setting machines, and when this is done, samples of the grommets, eyelets, or hooks to be used should be sent to the manufacturer to insure a properly designed set.

17. Equipment.—*a. Trimmer's table.*—The table for the average shop should be approximately 31 inches high, 5 to 7 feet wide, and 20 to 25 feet long. The top should be made of oak or maple, sanded smooth, varnished, and waxed. It is convenient to have the supplies in a cabinet at one end of the table, so that the material may be unrolled directly onto the table top. This keeps it clean and forms a convenient method of measuring, if one edge of the table is marked off in feet and inches.

b. Parachute folding tables.—Two tables, 20 feet long and 3 feet wide, placed end to end, are used for folding and packing parachutes. The top is finished in the same manner as the trimmer's table.

c. Parachute dummy.—This dummy is used for drop-testing parachutes. It is constructed of coils of rope covered with heavy duck and is equipped with metal fittings for attachment to bomb racks. It weighs approximately 115 pounds.

d. Bags, shot, 20 inches long, 5 pounds.—These are used for holding the folded panels of the parachute canopy in place before packing the parachute.

18. Sewing machine operation.—*a.* The feeding mechanisms of the different types of sewing machines are needle-feed, drop-feed, compound-feed, alternating-presser, and puller-feed.

(1) *Needle-feed.*—In this type of feed mechanism, the needle and needle bar of the machine move forward and down into the material, then back again the regulated length of a stitch, that is, the needle alone feeds the material, making a positive feed which is especially adapted to sewing parachute harness (webbing) and heavy leathers.

(2) *Drop-feed.*—This feeding mechanism consists of a feed dog, having teeth, which raises and feeds the material under the foot the regulated length of a stitch, and is not as positive as the needle feed. The drop feed is used for fabric and lightweight duck.

(3) *Compound-feed.*—The compound-feed consists of both the needle- and drop-feed and is particularly suited for sewing heavy duck, rubberized material, and light leather.

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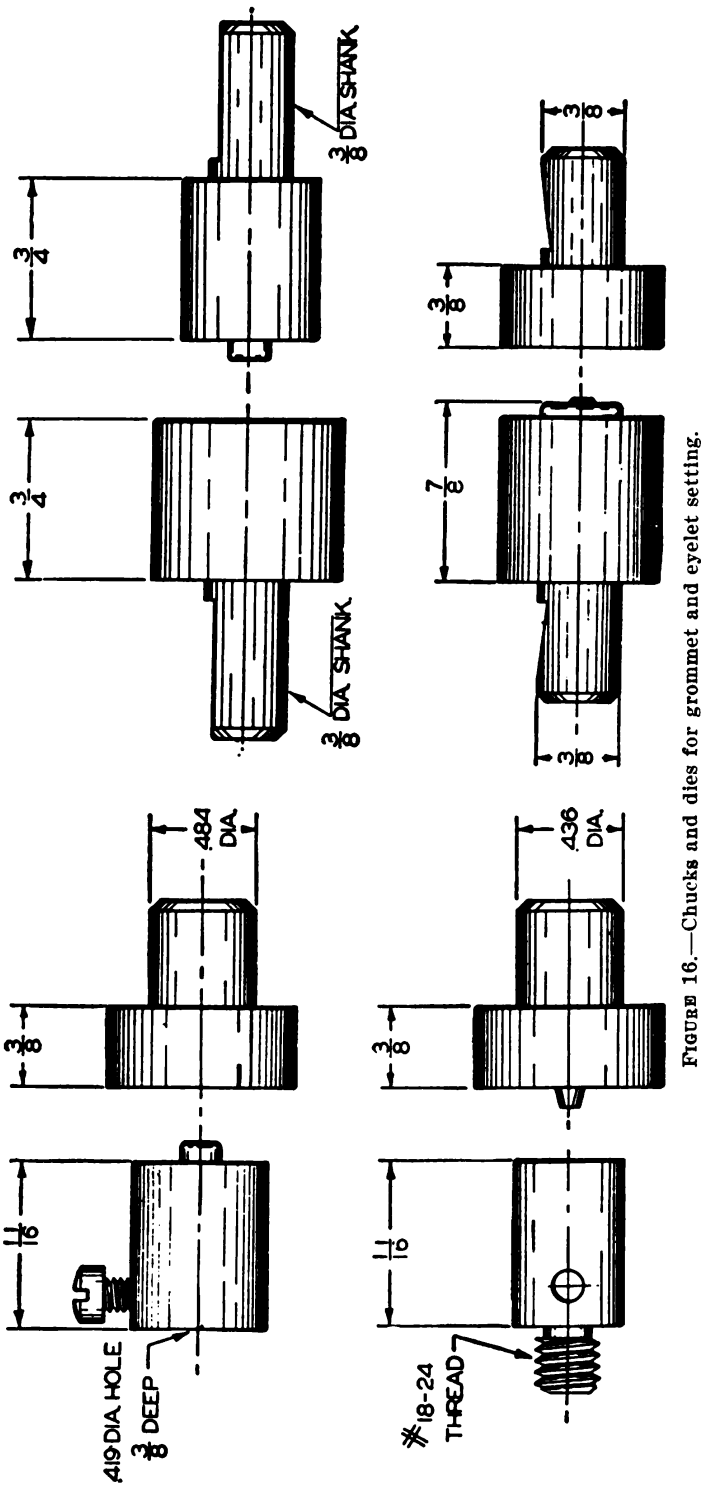

FIGURE 16.—Chucks and dies for grommet and eyelet setting.

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(4) *Alternating-presser.*—The alternating-presser is adjacent to the foot of the machine and works alternately with the needle-feed and drop-feed (compound feed) and is much more positive than the feeds previously mentioned. It is especially suited for stitching imitation leather upholstery and clothing made from sheep shearling.

(5) *Puller-feed.*—This feeding mechanism is used with two-needle machines and in conjunction with the compound-feed. It consists of two rollers located back of the two needles. This feed pulls and flattens the seam, holding a slight tension on the material while it is being sewed, eliminating much of the strain on the compound-feed while sewing heavy, bulky materials, such as leather, duck, and sheep shearling. It also facilitates the work of the operator, as it is unnecessary to hold the work at the back of the needles. When desired, this mechanism can be converted into a single-needle type by removing the right hand needle and bobbin.

b. Best performance of sewing machines may be obtained only by strict adherence to operating instructions. Some of the essential instructions are—

(1) Never operate a machine equipped with a compound-feed without material under the presser-foot, as this quickly dulls the feed-dogs.

(2) The balance wheel should not be turned backward a full turn, as this causes thread breakage.

(3) The machine should never be operated without material under the presser-foot when both the needle and bobbin are threaded, as this causes the thread to pile up or jam in the bobbin case, usually resulting in damage to the machine.

(4) Never pull the material back of the needle, as this will bend, dull, or break the needle.

(5) The plate over the bobbin case should always be kept closed while sewing, as the material may get caught in the shuttle or rotary hook, or the operator's fingers might be injured.

(6) To insure perfect action of a machine while sewing and to make a durable seam, the proper type of thread and size and class of needles should be used. If the thread is too large to pass freely through the needle eye, the machine will skip stitches or may not sew at all. If the needle is too large for the thread being used, the result will be a weak seam.

c. The needles on all one-line lock-stitch machines are threaded through the eye from left to right. The needles on all two-line lock-stitch machines are threaded from inside out. To set the needles, loosen the set screws in the needle clamp and put the needle up into

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the clamp, as far as it will go, with the long groove of the needle on all machines set in the same direction as for threading. Then tighten the set screw.

d. Before sewing can be done, it is necessary to draw the bobbin thread up through the needle hole under the presser foot. This is done by holding the needle thread loosely with the left hand, and turning the balance wheel forward toward the operator with the right hand until the needle moves down and up again to its highest point. The needle thread will have looped around the bobbin thread during the operation, and by pulling up on the needle thread the bobbin thread will be pulled up through the needle hole. If the needle thread is held too tightly while the balance wheel is being turned forward, it may not catch the bobbin thread.

e. The motor is started by turning the switch "on." The later types of motors for use on 110-volt single phase circuits do not use starting brushes and require a comparatively long time to attain full speed. Sufficient time must be allowed for the motor to attain full speed before starting to sew. The machine is started by pressing with the toe on the foot pedal. This engages a clutch which drives the machine, and the speed which the machine attains depends upon the pressure applied with the toe of the foot. The machine should be started slowly and, if the seam is long, made to attain its higher speed only after the seam is well started. All of the machines are capable of high speeds but this speed should not be used except by a skilled operator. The machine is stopped by relieving the pressure of the toe and pressing on the pedal with the heel. This disengages the clutch and applies a brake to the machine. From high speed, the machine may be stopped within a few stitches, and with a little experience the clutch pedal may be controlled so that one or more stitches may be made at will.

f. Making the seam.—(1) The presser foot may be operated by the hand lever at the back of the head and also by the knee lift. The use of the latter permits both hands to be free for holding and guiding the material and permits easing up on the pressure of the presser-foot when going over thick seams, and when anchoring each end of a finished seam.

(2) To start sewing, the bobbin and needle thread are held straight back behind the presser foot with the left hand. If the thread is not held with the left hand or foot of the sewing machine, it will usually jam up in the bobbin case or on the under side of the material.

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(3) The material is placed under the presser-foot and the foot lowered onto the material.

(4) The machine is started slowly by turning the balance wheel forward (toward the operator), and while the first few stitches are being made the needle and bobbin threads should be held under considerable tension with the left hand. After these first stitches, the threads are released and both hands used to guide the material through the machine. At the end of the seam, the machine is stopped with the pedal, and the balance wheel turned by hand until the thread take-up lever is raised to its highest point. The presser-foot is then raised by either the knee lift or the hand lever, and the work drawn back behind the presser foot, away from the operator, until 3 or 4 inches of the material have been drawn from the needle and bobbin. These threads may then be cut off leaving at least two inches in the machine with which to start sewing again. It is also advisable to place the needle and bobbin thread ends back under the presser-foot and let the presser-foot down on them to hold them in place; otherwise if the machine should be turned slightly the thread might be drawn through the needle, necessitating rethreading before sewing again. There is also some possibility of the needle thread getting pulled down into the shuttle and becoming tangled. Should the latter occur, the bobbin should be removed and the tangle released before attempting to do any more sewing. One of the most frequent causes of tangles in the shuttle or rotary hook is the failure to hold both the needle and bobbin thread taut when starting to sew.

(5) When sewing heavy leather, it is desirable and sometimes necessary that the needle thread is lubricated. Any machine can be equipped with a thread lubricator made especially for this purpose. Liquid sewing machine wax is used as the lubricant. Lubrication prevents fraying of the thread as well as overheating of the needle. It is especially necessary when sewing hard leathers.

g. Regulating tension.—(1) When a machine is operating properly, the needle and bobbin threads will be locked in the center of the material, as shown in figure 17 ②. This is accomplished by having the correct adjustment of tension on both the bobbin thread and the needle thread. The tension of the bobbin thread is produced by a flat spring on the bobbin case. The amount of pressure this spring exerts on the thread is controlled by a screw which holds the spring in place. Turning this screw to the right increases the tension and turning it to the left decreases the tension. The tension on the needle thread is controlled by the thumb nut on the tension disks. Turning this nut to the right increases the tension and turning it to the left decreases the ten-

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sion. If the needle thread is under too much tension or the bobbin thread too little, the needle thread will lie on the top surface of the material (fig. 17 ③). If the bobbin tension is too tight or the needle thread too loose, the bobbin thread will lie straight on the under surface of the material (fig. 17 ①). It is possible to have both tensions adjusted so that the threads are locked in the center of the material and both tensions may be either too loose or too tight. If too tight, excessive puckering of the material will be apparent and frequent thread breakage may occur. If too loose, the stitches will be loose and the pieces being sewed will not be firmly held together. The tension on the bobbin seldom requires adjustment, and changes in the tension to accommodate different thread or materials are ordinarily made on the needle thread by adjusting the thumb nut on the tension disks.

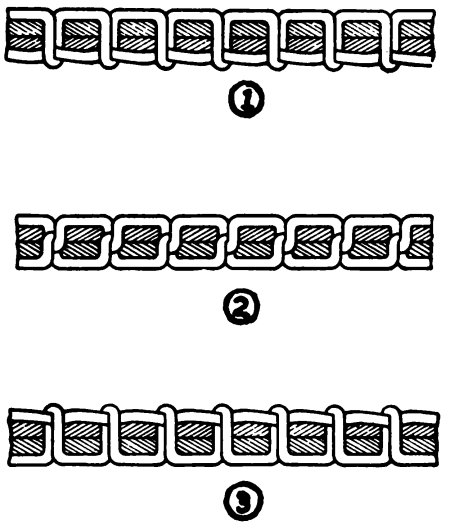

FIGURE 17.—Tension of needle and bobbin thread, lock stitch, type 301.

(2) The needle and bobbin thread should be locked as near as possible in the center of the thickness of the lower strip of leather or webbing, whether the work is of two or more plies.

h. Selection of needles.—(1) The selection of needles of correct size for the different machines and materials is necessary to eliminate thread breakage, skipped stitches, and chafing. For example: A number 13 or 14 needle is used for size A silk thread; number 18 or 21 needle, for size E silk thread; number 21 needle, for sewing lightweight material such as airplane fabric, duck, leather, and webbing with No. 16-4 cotton thread; and number 22 needle, for the heavier materials such as shearling, artificial leather, russet leather, heavy duck, and webbing with No. 16-4 thread. All elastic or rubberized materials require the use of a number 24 needle.

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(2) When, for any reason, a needle becomes dull it should be changed at once. A dull needle will cut threads (strands) in the material being sewn and may pull the threads, weakening the seam. The sharpness of a needle may be checked by sliding a finger nail over the point. If the needle scratches or catches the nail, it should be replaced with a new or sharpened one. Only needles with round, sharp points should be used for sewing cloth. These needles do not cut the strands as they are forced through the material. Diamond point needles will cut the strands and seriously weaken the seam and therefore are used only in sewing heavy leathers.

(3) Needles that become dull may be sharpened by using a small drill press or a hand drill and a sharpening stone. Needles that are bent or broken are replaced with new ones. When sharpening, the needle should be placed in the chuck of the drill as straight as possible and the drill operated at high speed. The sharpening stone (fine grade) is held lightly at the side of the point at the proper angle and the point polished to the highest degree of smoothness.

(4) The number of stitches per inch which a machine will produce may be regulated at the right of the balance wheel, or the upright part of the sewing machine arm. The knurled knob at the right of the balance wheel may be turned to the right or left, and the number appearing in the notch of the hub of the wheel indicates the number of stitches per inch the machine will produce, at any particular setting. The upright part of the arm has a thumb screw in a slot. To shorten the stitch this screw is loosened and moved upward and to lengthen the stitch it is moved downward. The regulation of stitches per inch is a very important factor in the strength of a seam.

(5) The number of stitches required depends entirely on the type of article and size of thread used. When drawings are available, stitches per inch will be in accordance with those specified. The reason for variation in the number of stitches per inch is due to the different thickness of material. Right twisted thread or cord is not permitted to be used on the lock-stitch sewing machines, as it will unwind when the needle thread is forming the lock in the bobbin case, resulting in loss of its normal tensile strength and a weak seam.

i. Changing the needle thread on machines from one color to another.—The old thread is cut above the first thread guide on top of the machine and the new thread placed on the thread unwinder and tied to the old thread with a square knot. The old thread is

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then pulled at the needle. While pulling the thread through the thread guides, the needle tension releasing disk must be released by raising the foot as high as it will go, which allows the knot to slip through the tension of the releasing disks without obstruction. The knot is then cut and the needle rethreaded.

19. Maintenance of sewing machines.—*a. Lubrication.*—(1) When in continuous use, the moving parts of the sewing machine head should be oiled regularly twice a day. Each time a bobbin of the rotary type is changed, one drop of oil should be placed on the hook and bobbin case race, keeping the bobbin and parts beneath properly lubricated. This does not apply to the oscillating shuttle type machines. The lubricant used should be a very high grade oil; refrigerator lubricating oil, grade 100, is recommended.

(2) If, at any time, the machine becomes loggy, it is usually the result of using improper oil or the accumulation of dust and lint, which will gum the bearings, gears, etc. To eliminate this trouble, the proper oil should be used and the machine covered when not in use. The cover should be made of artificial leather, as duck is not dustproof.

(3) The machine should be cleaned at least once a year, or at any other time it is evident that cleaning is necessary. Bearings may be cleaned by inserting noninflammable cleaning fluid at each oiling point while the machine is in operation, and then applying compressed air until dry. After cleaning, the machine must be thoroughly re-oiled.

(4) Compressed air used for cleaning or drying the machine, after using the cleaning fluid, should be free from water, as water will cause rust or corrosion in the gears, bearings, etc.

(5) The electric motor bearings require lubrication about once each six months. Medium or light grease is used for this purpose. Too much grease should be avoided, as it will get into the motor with damaging results.

b. Adjustment of timing and the replacement of parts.—A thorough understanding of the construction of the machine and its principles of operation are necessary before attempting timing adjustments or replacement of parts. The manufacturer's handbook provides information for this kind of work and should be followed when possible. Minor adjustments, such as the adjustment of tension, regulation of the length of stitch, and the changing of needles and bobbins, should be done by the operator as required.

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SECTION III

MODIFICATION AND MAINTENANCE OF CLOTHING AND FLYING EQUIPMENT

	Paragraph
General	20
Protection of clothing from moths	21
Identification markings, insignia, names, etc	22
Cleaning and treatment of flying clothing	23
Design and application of seams	24
Repair and maintenance of flying clothing	25
Assembly, attachment, and repair of interlocking fasteners	26
Manufacture and maintenance of fabric equipment	27
Manufacture and maintenance of leather equipment	28
Knots, splices, etc.	29
Installation of headsets on helmets	30
Adjustment and alinement of goggles	31

20. General.—*a.* When repairing garments, such as replacing torn sections, all the old thread must be removed, and the new seam made so that none of the old needle holes show. All thread should match the color of the material; in some instances two thread colors are required, one to match the outer shell and the other to match the lining. To give a seam maximum strength, it is necessary to use the correct machine thread and amount of stitches per inch. The seam should be of the correct type and the proper distance from the edge, the tensions should be properly adjusted, and the correct types of needles used. The seams should be locked (anchored) at each end and points of greatest strain, such as corners, pockets, glove fasteners, etc., and should be reinforced with a patch. Care should be exercised to keep the articles as clean as possible by keeping the floors, benches, hands, and machines free from dust, dirt, and grease.

b. In order to explain this work, typical repairs, hand and machine seams, etc., have been selected and the best methods applicable have been illustrated and described. However, in practice it will sometimes be necessary to deviate from these methods.

21. Protection of clothing from moths.—Articles of clothing comprising woolen fabrics or furs, or articles fitted with linings, trimmings, etc., of these materials, must be properly treated and stored when not in use to prevent damage by larvae.

a. Preparation for storage.—All Air Corps clothing requiring protection from moths should be treated in the following manner before being placed in storage. Each article should be cleaned, vigorously shaken, and thoroughly brushed. Where possible, each

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article should be turned inside out, reshaken and brushed, and then turned right side out. The brushing should include all seams, folds, etc., and the inside of pockets. This is necessary to remove all forms of the moth before storing the article. Instructions for cleaning leather articles are covered in paragraph 23.

b. Storage.—(1) Where clothing cold-storage facilities are not available, each garment after seasonal use is treated by sprinkling with flakes of naphthalene and carefully packed in suitable paper-lined wooden boxes, strong pasteboard boxes, or inclosed in suitable paper covers and suspended from a rack by means of wooden clothes hangers. Each box and paper-covered package is sealed as nearly airtight as possible to prevent escape of the naphthalene fumes and entrance of moths. The fumes are not effective unless well confined, as moths can enter the package through a very small opening. If a paper cover is used, care should be taken at all times to prevent tearing or otherwise making openings in the wrapping. In the event a paper cover becomes torn, it should be immediately replaced. The amount of naphthalene flakes to be used should be in the ratio of 1 pound to 6 cubic feet of box or package content. When paper wrappers are used, one-half pound of naphthalene flakes is used for each garment. After packing, the clothing should be kept in a dry storage room. Whenever the containers are opened for the addition or removal of garments, or for any other reason, additional naphthalene flakes are added as required.

(2) Where it is necessary to maintain a small quantity of clothing for frequent issue, such clothing may be stored, unpacked, in a well sealed locker, closet, or other small enclosure. The floor, shelving, etc., of such containers should be kept well sprinkled with naphthalene flakes. Since these flakes evaporate rapidly when not confined, they must be replenished as required.

22. Identification markings, insignia, names, etc.—*a.* No identification markings, insignia, names, etc., are placed on articles of individual flying clothing (except as noted for mechanics' suits) in such manner as will prevent subsequent issue of the clothing to individuals of other organizations. Approved Air Corps organization insignia are used on flying jackets and flying suits only by placing the insignia on a circular leather patch, 5 inches in diameter, sewn to the left breast of the garment. These patches may be obtained by requisition.

b. Flying clothing issued to commissioned personnel have the name of the individual placed on leather strips sewn on the garment ½ inch above the organization insignia patch. Only the first and

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middle initials and the last name of the individual are used. These name plates, stamped for each individual, may be obtained by requisition.

c. Flying clothing issued to enlisted personnel, including mechanics' suits, have the name of the individual stenciled, with letters not more than ½ inch in height, on a strip of fabric (cotton serving tape, ¾ inch wide) sewn to the garment in the same location as prescribed in *b* above. Indelible, waterproof ink for marking fabrics, specification TT–I–542, is used for this purpose.

d. Bags that are permanently issued are marked with the name and grade of the individual. For this purpose, a piece of 1 inch cotton reinforcing tape of sufficient length for the name and grade of the individual to be stenciled thereon in ½-inch letters is sewed on the bag. The tape is located in the 1-inch space between the leather top reinforcement on which the handle is installed and the individual pocket on the outside of the bag.

e. In view of the possibility of the tearing of garments, loss of insignia badges, and fouling of parachute suspension lines when the parachute is employed in an emergency, no metallic badges of any kind, either to denote the organization or the grade of the individual, are worn on the shoulders of outer flying jackets or flying suits. However, nonmetallic shoulder insignia to denote the grade of commissioned personnel should be attached. Flat leather insignia badges in all required grades may be obtained for this purpose on requisition. They are attached by means of cement to a small leather patch which is sewed to the garment. Insignia on shoulder loops are worn as follows:

(1) *General.*—Four stars, points up, to be equidistant, each from the other.

(2) *Lieutenant general.*—Three stars, points up, to be equidistant, each from the other.

(3) *Major general.*—Centers of the two stars, points up, 2¼ inches apart, the stars to be equidistant from the sleeve end of the loop and the outer edge of the button.

(4) *Brigadier general.*—Star in center of loop, point up.

(5) *Colonel.*—Eagle, head up, beak to the front, in middle of loop, talons of eagle ⅝ inch from sleeve end of loops.

(6) *Lieutenant colonel.*—Oak leaf, point up, in middle of loop, stem of leaf ⅝ inch from sleeve end of loop.

(7) *Major.*—Oak leaf, to be worn same as oak leaf of lieutenant colonel.

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(8) *Captain.*—Two bars, ¼ inch apart, in middle of loop, lower bar parallel to and ⅝ inch from sleeve end of loop.

(9) *First lieutenant.*—Bar in the middle of loop, parallel to and ⅝ inch from sleeve end of loop.

(10) *Second lieutenant.*—Same as first lieutenant.

(11) *Warrant officer.*—None.

23. Cleaning and treatment of flying clothing.—*a.* Before leather clothing is placed in storage it should be thoroughly cleaned by a master dry cleaner. Leather articles which have the grain surfaces (outer or hair surface) exposed are treated with soft soap, specification 18001, as follows:

(1) Prepare a lather which has the appearance and consistency of whipping cream and apply to the leather at intervals until it has worked into the leather.

(2) Apply only the dry lather as the liquid soap is detrimental to the leather.

(3) When the sponge with which the lather is being applied becomes soiled from the dirt on the article, wash out and relather.

(4) Remove all surplus lather from the surface of the article with a clean, dry cloth.

(5) Suspend article so that air can circulate about it freely to permit thorough drying before it is placed in storage.

b. Leather articles which are in constant use are treated once each year or at such time as an inspection indicates that it is necessary.

c. Noninflammable cleaning fluid is used for cleaning dirt and grease spots from clothing, etc. A cleaning fluid consisting of equal parts (by volume) of naphtha, specification 4–1040, and carbon tetrachloride, specification 4–503–110A may be used for cleaning and will not destroy cloth or leather. When cleaning with this fluid, a clean cloth is moistened and used to rub the area lightly with a circular motion until clean. These chemicals should be mixed in small quantities due to rapid evaporation. The fluid is noninflammable; however, if the naphtha is separated through evaporation of the carbon tetrachloride, the naphtha becomes flammable. This mixture should not be applied to heated parts, as carbon tetrachloride produces highly poisonous fumes when heated. As a precaution against the toxic effects of carbon tetrachloride, rubber gloves should be worn, and work should be conducted in well-ventilated rooms, preferably where exhaust fans are available. Breathing the gases of this volatile mixture should be avoided.

d. After cleaning leather garments with this fluid the area should be treated with soap, as explained in *a* above.

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24. Design and application of seams.—*a. General.*—In order to interpret instructions relative to seams, an understanding of the following terms is essential.

(1) A "stitch" is the unit of thread formation in the production of seams and stitching.

(2) A "seam" consists of a series of stitches joining two or more plies of a material or materials.

(3) "Stitching" consists of a series of stitches embodied in a material for ornamental purposes or for finishing an edge or for both. A seam is used for joining or assembling materials in the production of an article, whereas stitching is used for preparing parts for assembling, and includes ornamenting and finishing, such as gimp stitching, panel stitching, hemming, and similar operations.

b. Types.—Seams in general are divided into five classes and the seams in each class are subdivided into types. Each class and type is given a symbol for convenient reference. The symbol for each seam is divided into three parts. The first part denotes the class of seam, and consists of two or more upper case letters, for example, "SS." The second part denotes the type of the class, and consists of one or more lower case letters, for example, "a." The third part denotes the number of rows of stitches used, and consists of one or more Arabic numerals preceded by a dash, for example, "–1." The complete symbol thus becomes "SSa–1."

(1) The specification of a seam includes the seam symbol prefixed by the symbol of the stitch to be used therein, thus a seam type SSa–1 formed with United States standard stitch type 301 is specified, "301–SSa–1."

(2) Machine sewed seams or stitches are indicated by dotted lines on all illustrations. Whenever it is possible to do so, all stitches should be made on the outside (top) of the material as the needle makes a rough surface on the under side.

(3) When sewing, perfect control of the sewing machine is essential at all times, that is, be able to take only one stitch, if necessary, and to make straight seams. To make a straight seam, the edge of the machine foot is used to gage the distance from the edge of the material. When this is not possible the material should be marked with a pencil.

(4) All machine sewed seams described herein are of the two thread lock stitch, type 301, as shown in figure 17.

(*a*) The two thread lock stitch is used for sewing one or more rows of stitches, using a single needle machine.

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(*b*) The two line lock stitch is used where two rows of stitches are required, at a given distance apart, such as the overlap seam, type LSa–2, and the fell seam, type LSc–2, using a two needle machine.

c. Characteristics of seams.—The characteristics of properly formed seams are strength, elasticity, durability, security, and appearance.

(1) *Strength.*—A seam should be of sufficient strength to withstand the strain to which it will be subjected in the use or wear of the article of which it is a part. The elements affecting the strength of a seam are—

(*a*) Type of stitches used.
(*b*) Thread combination used.
(*c*) Number of stitches per unit length of seam.
(*d*) Tightness of seam.
(*e*) Construction of seam.
(*f*) Size and type of needle point used.

(2) *Elasticity.*—The elasticity desirable in a seam is determined by the elasticity of the material to be sewed. The elasticity of the seam should be equal to the material or materials joined.

(3) *Durability.*—The durability of a seam depends largely upon its strength and the relation between the elasticity of the seam and the elasticity of the material. In the less elastic, tightly woven, and dense materials, there is a tendency for the plies to "work" or slide, each on the other, especially sheep shearling. To form a durable seam in such materials, the stitches must be tight and the thread well set to the material to minimize abrasion and wear by contact with outside agencies.

(4) *Security.*—The security of a seam depends on the character of the seam, on the strength and durability of the thread used in forming the stitch, and on the type of stitch employed.

(5) *Appearance.*—The appearance of a seam is largely controlled by the seam construction. Under certain conditions it is essential that both sides of the seam appear the same, as for instance, edge stitching of jackets where the lapel, collar, or the front of a jacket is turned. Each of these factors must be considered in determining the type of stitches to be employed in a seam for any given operation.

d. Reinforcing seam.—(1) Double stitched seams are necessary for certain types of seam formation, such as where there are no added stitches after the seam has been turned. When it is necessary to reinforce a seam, two rows of stitches $\frac{1}{32}$ inch to $\frac{1}{8}$ inch apart are

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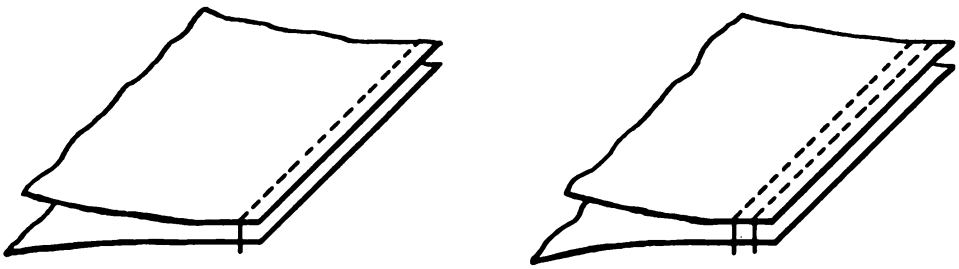
made as shown in figure 18 ②. If the seams were made one on top of the other, the lock of the first seam would be cut occasionally by the needle while the second row of stitches was being made, thereby weakening the seam. This will occur more frequently when heavy materials, thick seams, and large needles are being used.

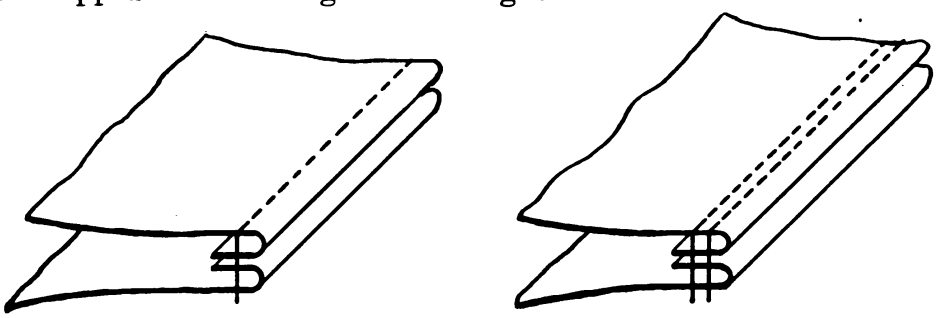


① Type SSa–1. ② Type SSa–2.

FIGURE 18.—Seams.

(2) All seam ends of fabric materials should be securely locked by over-stitching, back-stitching, or triple-stitching for a distance of not less than ½ inch. All seam ends of leather materials should be securely fastened with a square knot by pulling the two locks of the thread on the under side or between the thicknesses of the material. The latter method is especially adapted for finished machine seams.

e. United States standard seams, class SS (superposed seam).—In this class of seam the plies of material are superposed and joined with one or more rows of stitches along the edge of the material. The edges may be folded under but the plies of material are never overlapped when the original stitching is made.



① Type SSc–1. ② Type SSc–2.

FIGURE 19.—Seams.

(1) *Seam, type SSa–1 and SSa–2.*—These seams are formed by superposing two or more plies of material and uniting them with one or two rows of stitches (fig. 18). These seams are the first step in the formation of other types of seams, and are seldom used alone

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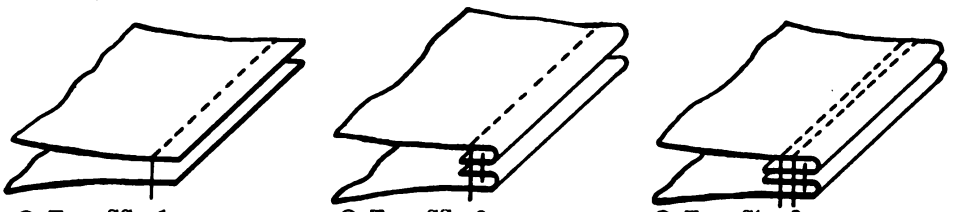
except on leather, selvage edges, and on raw edges of cloth, webbing, etc., that have been waxed. A plain raw edge is always turned under as in forming seam type SSe-2 (fig. 20 ②).



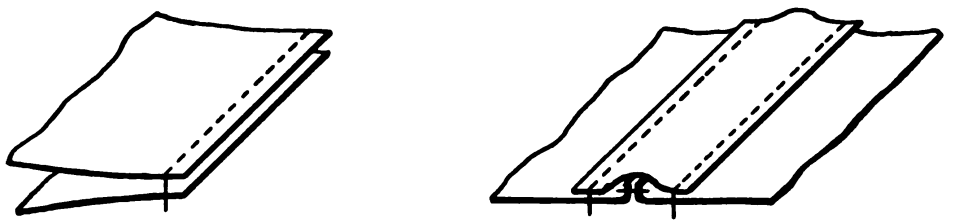
① Type SSa-1. ② Type SSe-2. ③ Type SSe-3.

FIGURE 20.—Seams.

(2) *Seam, type SSc-1 and SSc-2.*—These seams are formed by turning the edges of both plies of material to the inside and uniting with one or two rows of stitches (fig. 19). These seams are used where it is impossible to use the seam formation shown in figure 20.

(3) *Seam, type SSe-2 and SSe-3.*—In forming these seams the plies of the material are first superposed and seamed as in forming seam type SSa-1 (fig. 20 ①). The plies of the material are then turned and joined with one or two rows of stitches (fig. 20 ② and ③). These seams are used in making cuffs, collars, etc., and edge stitching on coats of flying clothing.

(4) *Seam, type SSf-3.*—In forming this seam, the plies of the material are first superposed and seamed as in forming seam type SSa-1 (fig. 21 ①). The plies of the material are opened and a



① Type SSa-1. ② Type SSf-2.

FIGURE 21.—Seams.

reinforcing tape or strip of leather attached with two rows of stitches (fig. 21 ②). This seam is used where it is necessary to reinforce by taping raw edges of clothing, covers, etc., manufactured from leather, fabric, duck, or rubberized material. It can be used as a substitute for the furrier's seam.

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(5) *Seam, type SSl–1.*—This type of seam is formed by turning the edge of one ply of material and joining with one row of stitches (fig. 22). It is used on clothing and covers where it is necessary to

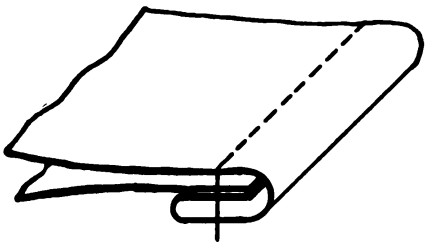
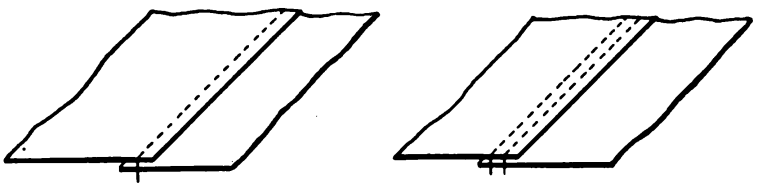


FIGURE 22.—Seam, type SSl–1.

have the outside edge smooth and eliminates the use of binding tapes.

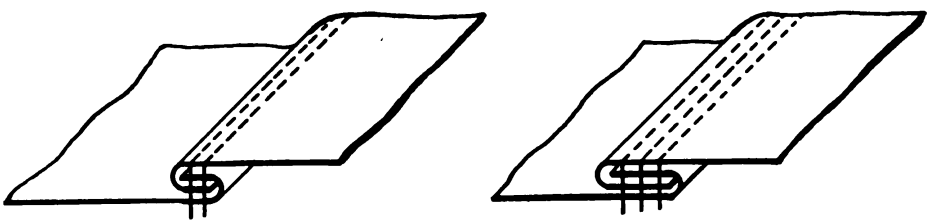
f. United States standard seam, class LS (lap seam).—In this class of seam the plies of material are overlapped a sufficient distance to hold the stitches and are joined with one or more rows of stitches.



① Type LSa–1. ② Type LSa–2.

FIGURE 23.—Seams.

(1) *Seam, type LSa–1 and LSa–2.*—These seams are formed by overlapping two or more plies of material and uniting them with one or two rows of stitches (fig. 23 ① and ②). These seams are used for seaming strips of duck or fabric and pieces of leather. When joining strips of artificial leather, duck, or fabric, these seams are used only along the selvage edges of the material.



① Type LSc–2. ② Type LSc–3.

FIGURE 24.—Seams.

(2) *Seam, type LSc–2 and LSc–3.*—These seams are formed by turning the edges of both plies of the material, lapping and uniting them with two or three rows of stitches, which also secures the turned

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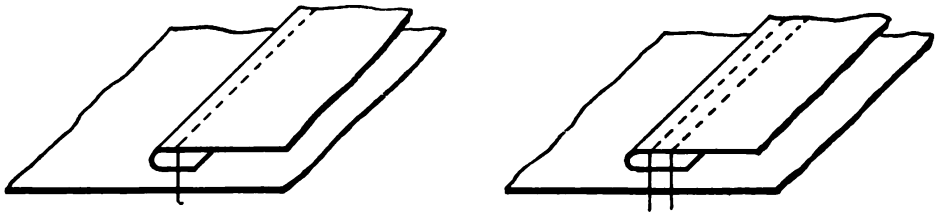
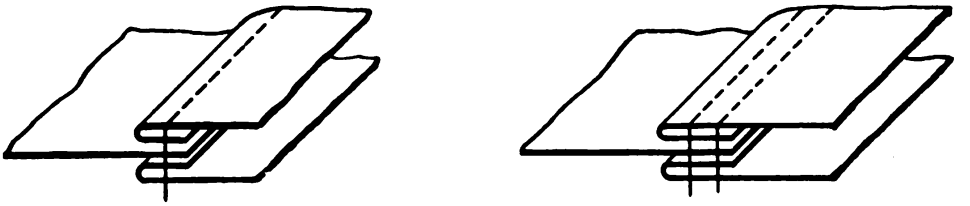
portions as shown in figure 24. The edges of the material are concealed. These seams are used for the same purpose as the LSa–1 and LSa–2 types (fig. 23 ① and ②) except that raw edges may be used. The type LSc–2 (fig. 24 ①), seam is made on a two needle machine with needles ⅛ inch apart or over, and an attachment known as a folder for guiding the material into the machine is used. This type of seam is preferable to the type LSa–2 (fig. 23 ②) seam as it is much stronger and smoother, especially under tension.



① Type LSd–1. ② Type LSd–2.

FIGURE 25.—Seams.

(3) *Seam, type LSd–1 and LSd–2.*—These seams are formed by turning the edge of one ply of the material, lapping it on another ply of material a substantial distance from the edge, and joining the plies with one or two rows of stitches (fig. 25). These seams are used for attaching pockets on clothing and interior and exterior pockets on flying clothing bags, where a neatly finished edge is required.



① Type LSe–1. ② Type LSe–2.

FIGURE 26.—Seams.

(4) *Seam, type LSe–1 and LSe–2.*—These seams are formed by turning the edges of two plies of material, inserting a third ply, and uniting all plies with one or two rows of stitches (fig. 26). These seams are used when attaching wristlets or skirts to flying jackets.

(5) *Seam, type LSae–1.*—This seam formation is made by folding one or more plies of material and uniting with another ply (fig. 27 ①). This formation of piping is used where small pockets are required for holding various articles, tools, etc., and for under sewing cushions that are stuffed with kapok.

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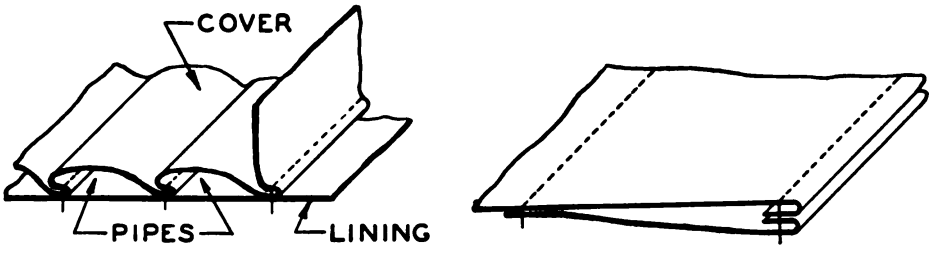
(6) *Seam, type LSag-2.*—This seam is formed by turning one edge of a strip to the inside, turning the edge of the body material to the inside, and uniting with two rows of stitches (fig. 27 ②). This seam is used as a reinforcement on clothing and covers.



① Type LSae-1. ② Type LSag-2.

FIGURE 27.—Seams.

g. United States standard seam, class BS (binding seam).—This class of seam is formed by folding a binding strip over the edge of one or more plies of material and joining the plies and binding strip with a series of stitches.

① Type BSa-1. ② Type BSa-2.

FIGURE 28.—Seams.

(1) *Seam, type BSa-1 and BSa-2.*—These seams are formed by folding a binding strip over the edge of the ply or plies of body material and uniting the binding strip and body material with one or two rows of stitches (fig. 28 ① and ②). These seams are used on flying clothing, parachute packs, and small panel work.

① Type BSc-1. ② Type BSc-2.

FIGURE 29.—Seams.

(2) *Seam, type BSc-1 and BSc-2.*—These seams are formed by turning both edges of a binding strip, folding it over the edge of the ply or plies of body material, and uniting the binding strip and

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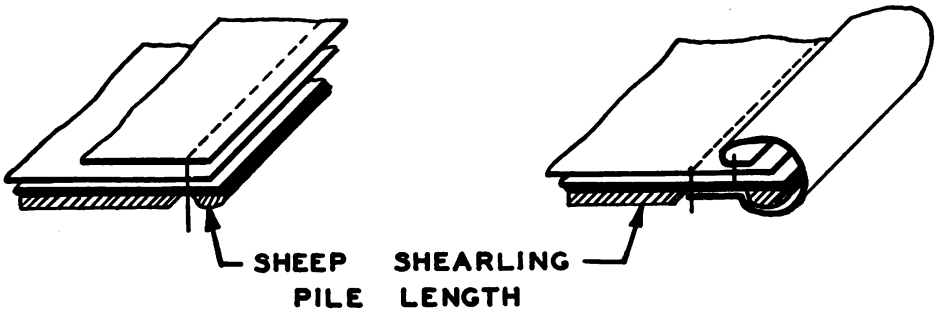
body with one or two rows of stitches (fig. 29 ① and ②). These seams are used as a binding for covers, panels, bags, helmets, etc., especially when using material that will fray, such as cloth or artificial leather.

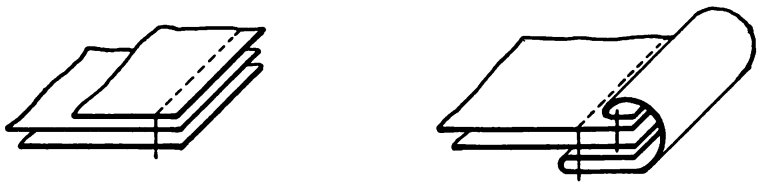
(3) *Seam, type BSf-2.*—This seam is formed by joining a strip to the body material, as in forming type SSa-1 seam (fig. 30 ①). The strip is then folded over the edge of the body material and united with the body material with a second row of stitches (fig. 30 ②). This seam is used for seaming and binding the edge on helmets, gauntlets, and shoes.



① Type SSa-1. ② Type BSf-2.

FIGURE 30.—Seams.

(4) *Seam, type BSg-2.*—This seam is formed by joining a strip to the body material as in forming type SSa-1 seam (fig. 31 ①). The edge of the strip is then turned and the strip folded over the edge of the body material and united with the body material with a second row of stitches (fig. 31 ②). This seam is used for seaming and binding the edge on cloth helmets.



① Type SSa-1. ② Type BSg-2.

FIGURE 31.—Seams.

h. Stitching.—Stitching is divided into classes and each class divided into types. Each class and type is given a symbol similar to the system of classifying seams. The specifications of stitching are the same as for seams.

i. United States Standard stitching, class OS (ornamental stitching).—This class of stitching has a series of stitches embodied in a material either in a straight line, a curve, or following a design for ornamental purposes.

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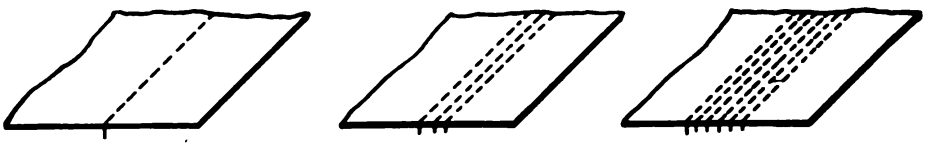
(1) *Stitching, type OSa-1, OSa-3, and OSa-6.*—This type of stitching is produced with one to six rows of stitches (fig. 32 ①, ②, and ③). It is used for ornamental purposes such as on belts, straps, collars, etc.



① Type OSa–1. ② Type OSa–3. ③ Type OSa–6.

FIGURE 32.—Stitching.

(2) *Stitching, type OSd-2.*—This stitching is produced by inserting a cord between two plies of material and uniting the plies with two rows of stitches, one row on each side of the cord (fig. 33). This type is used for finishing the edge on helmets. The purpose of the cord is for use as a drawstring.

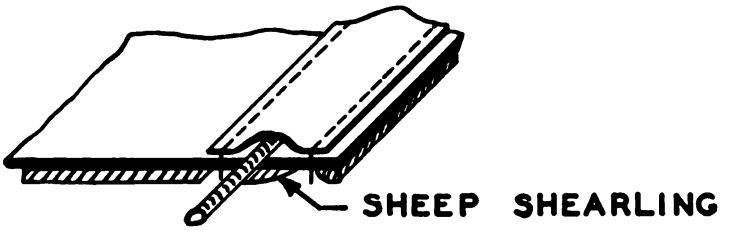
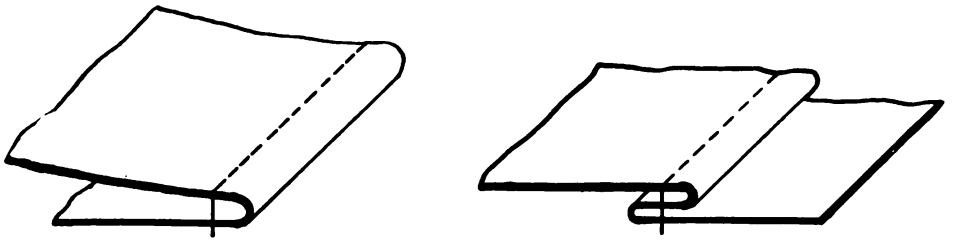


FIGURE 33.—Stitching, type OSd–2.

(3) *Stitching, type OSf-1 and OSe-1.*—The type OSf–1 stitching is produced by folding and uniting the plies of material near the fold (fig. 34 ①). This type is used for tucking purposes on clothing



① Type OSf–1. ② Type OSe–1.

FIGURE 34.—Stitching.

and pockets of fliers' clothing bags. The type OSe–1 stitching is produced by folding the material and uniting the fold with the body of the material with one row of stitches (fig. 34 ②). This type is used for tucking or pleating.

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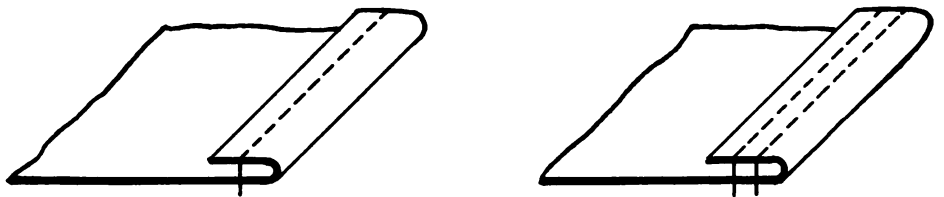
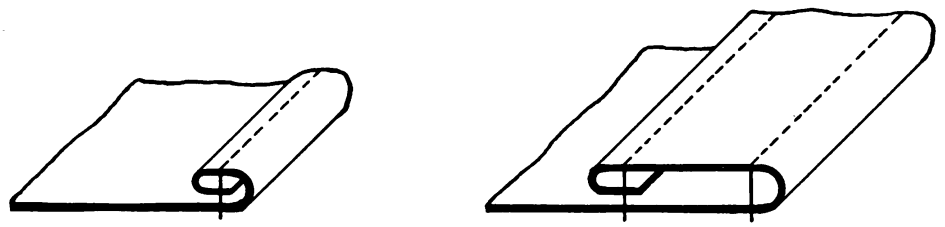
j. United States stitching, class EF (edge finishing).—In this class of stitches the edge of the material is folded and joined to the body of the material with a series of stitches for edge finishing.



① Type EFa–1. ② Type EFa–2.

FIGURE 35.—Stitching.

(1) *Stitching, type EFa–1 and EFa–2.*—This stitching is produced by turning the edge of the material and uniting the portion so turned to the body of the material with one or two rows of stitches (fig. 35 ① and ②). It is used for hemming the edges of covers, panels, tapes, and webbing.



① Type EFb–1. ② Type EFb–2.

FIGURE 36.—Stitching.

(2) *Stitching, type EFb–1 and EFb–2.*—This stitching is produced by turning the edge of the material, folding it back over the body of the material, and uniting the portion so turned and folded to the body of the material with one or two rows of stitches (fig.

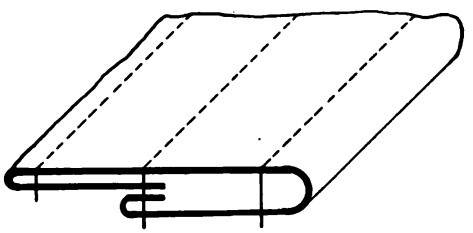


FIGURE 37.—Stitching, type EFj–3.

36 ① and ②). This type is used for large covers, panels, etc. It is employed where the salvage edge has been cut or requires a reinforcement for setting grommets, eyelets, hooks, etc. The type EFb–1 stitching may also be used as a drawstring hem on bags.

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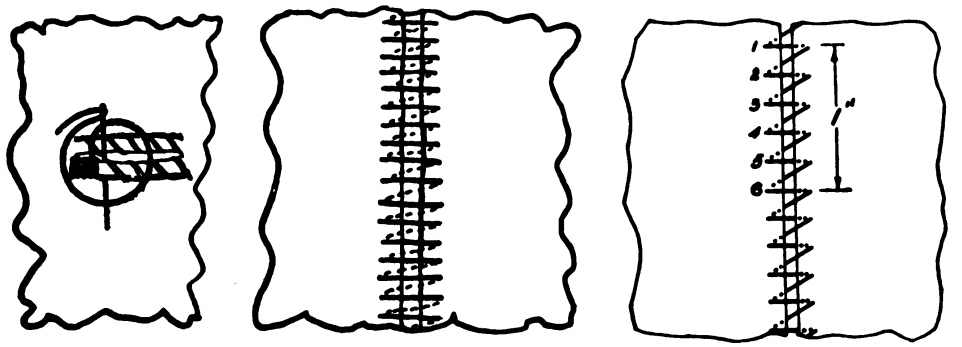
(3) *Stitching, type EFj-3.*—This stitching is produced by turning both edges of a strip of material and overlapping the edge. One of the edges is again folded, and the portions so turned and overlapped are united with three rows of stitches (fig. 37). This type of stitching is used for making straps for clothing made from cape, horsehide leather, or cloth.

k. Hand sewed seams.—Hand sewed seams (fig. 38) are made with either the baseball, plain overthrow, or button hole stitch. Most hand sewing is done with the baseball stitch (Fig. 38 ③). The plain overthrow stitch (fig. 38 ②) is used for repairing a weakened seam, reinforcing ends of interlocking fasteners, attaching fittings, etc. The button hole stitch (fig. 38 ①) is used to reinforce openings or small holes in bags, covers, clothing, etc., where there is considerable



① Button hole stitch. ② Plain overthrow stitch. ③ Baseball stitch.

FIGURE 38.—Hand sewed seams.

strain. Another type of seam which is not illustrated but frequently used is the basting seam. It is only used for temporary sewing of plies of material on clothing, covers, etc. before machine sewing. Hand sewed seams should have six stitches (each side) per inch, and under no circumstances should there be less than four per inch. Stitches should be uniform and neat in appearance. When hand sewing cloth, ½ inch should be turned under as reinforcement and the needle inserted from the inside about 1/16 inch from the folded edge. The edge is not turned under when hand sewing thick materials, such as sheep shearlings, felt, etc. When sewing sheep shearling the needle should be inserted from the top side, ⅛ inch from the edge of the tear (opening). All hand sewed seams are required to be locked at each end of the seam with two half-hitch knots. If the mechanic is right handed it is best for the seam to be

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made from right to left, and the thread should be held tight with the left hand, while each stitch is being made. This keeps the stitches from loosening and makes a tight seam.

(1) The baseball stitch is formed with a double thread, knotted at the end. The needle (and thread) is passed through the material extending outwardly from the opening on the top or bottom side, 1/16 to 1/4 inch from the edge of the opening, and then carried directly across to the opposite side of the material. Each new stitch is entered from the same side. It is then carried forward to the opposite side for the succeeding stitch and this operation repeated to form a sequence of stitches until finished.

(2) The overthrow stitch is formed with a double thread, knotted at the end. The needle (and thread) is passed through the material from the bottom side, extending outward from the opening, 1/16 to 1/8 inch from the edge of the opening, and then carried directly across to the opposite side of the material. The thread is then passed through from the top side and carried forward to the original side, then entered from the bottom for the succeeding stitch. These operations are repeated to form a sequence of stitches until finished.

(3) The button hole stitch is formed with a single thread, knotted at the end. The edge of opening is first whipped with a series of overthrow stitches to hold the plies of material. The needle (and thread) is passed through the material from the under side extending outwardly from the opening 1/8 inch, and passing through the loop of thread. The stitch is drawn snugly (not puckering) to form the loop on the inside edge of the opening. These operations are repeated to form a sequence of stitches, 1/16 inch apart on thin materials and a little farther on heavy materials until finished.

(4) The basting stitch is formed with a single thread, knotted at the end. The edge or edges of plies of material are held together by inserting the needle in and out, from top to bottom, to form a sequence of stitches.

25. Repair and maintenance of flying clothing.—*a. Repair of tears on clothing manufactured from sheep shearling.*—(1) When repairing clothing, the repair should in no way detract from the original appearance of the garment, but should appear as though it were intended for reinforcement. When making the repair, the garment should be placed over a smooth surface or projecting arm. Small tears are repaired by sewing the torn edges together with the baseball stitch (fig. 39 ②), using size E, brown silk thread. The

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ends and corners are reinforced with an overthrow stitch, to prevent the tear from spreading at each end. The overthrow stitch at the end should extend approximately ⅛ inch past the ends of the tear. The corners are always sewed first in order to hold the material in the proper position and to obtain the proper tension while sewing. When sewing through the leather of shearling, the needle is inserted only deep enough to catch the leather without catching any more of the wool than is necessary (fig. 39 ①). If the preceding instructions are carefully followed in all repairs and the edges of the tear drawn together properly, it will be very difficult to determine where the repair has been made.

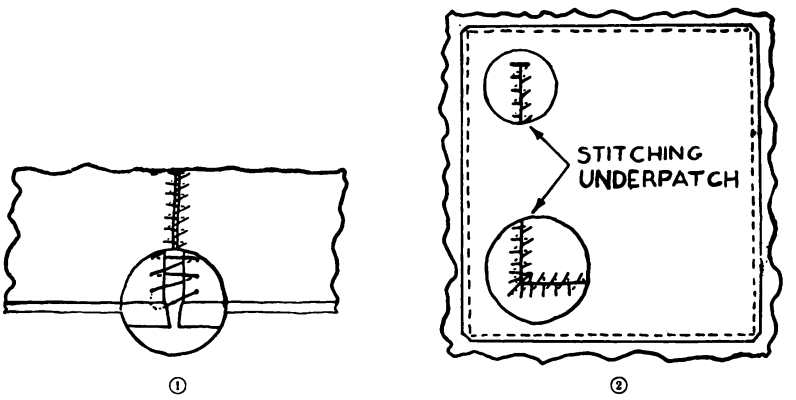

FIGURE 39.—Method of repairing tears in sheep shearling.

(2) A square or rectangular shaped patch of sufficient size to extend about ¼ inch beyond the tear is placed over each tear. The patch is cut from cape leather and machine sewed (not more than 8 stitches per inch), approximately 1/16 inch from the edge, using size E, brown silk thread. All corners are clipped at a 45° angle to keep them from turning up. This also gives the patch a more finished appearance.

b. Types of tear repairs.—The different types with numbers and letters to indicate the location of each stitch are shown in figure 40.

c. Sewed in patch.—If the shearling of flying garments is damaged to such an extent that a small portion of it is missing and none of the previously mentioned methods can be used, it is repaired in the following manner: The edges of the damaged portion are cut out, making a rectangular or square shaped opening. A piece of shearling of sufficient size is fitted into the opening. All four corners are sewed first in order to obtain the proper tension and hold the patch in place.

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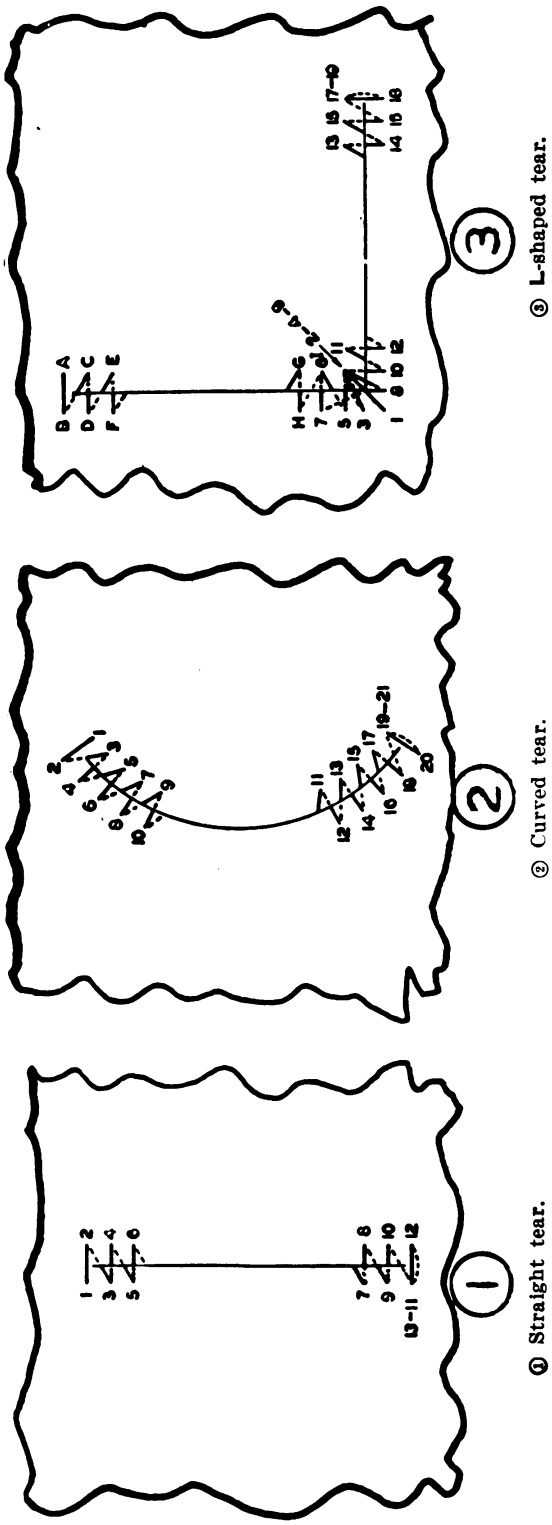

① Straight tear.

② Curved tear.

③ L-shaped tear.

FIGURE 40.—Various types of tear repairs.

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The sewing is then continued entirely around the patch, skipping each corner on the inside with one stitch. A patch of this type (with enlarged stitches at one corner) is shown in figure 41.

d. Repairing damaged sleeves.—When it is necessary to repair sleeves, due to tears, ripped seams, worn spots, etc., make alterations, or reinforce the sleeve at the elbow, the seam must be opened. The repairs are then made as previously explained. When alterations are necessary, the sleeve should be measured and fitted before the seam is made. The sleeve should be machine sewed so that none of the needle holes made by the old seam are exposed.

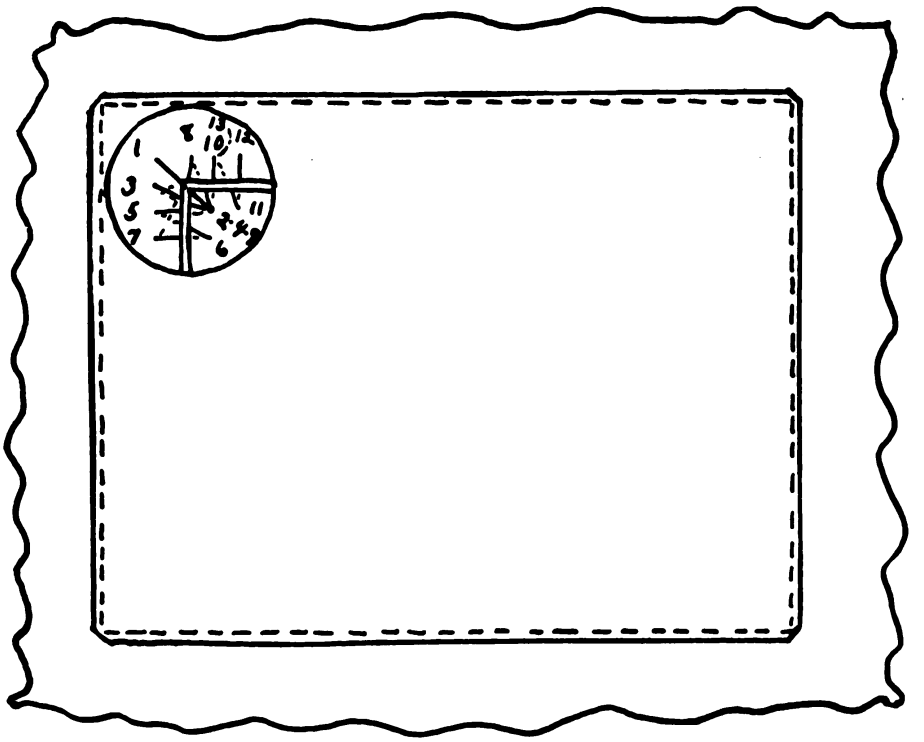

FIGURE 41.—Sewed in patch.

e. Reinforcements.—Reinforcements are made on garments to strengthen points of greatest strain. All machine and hand seams are reinforced with double stitching or knotted with two or three square knots at each end. Exposed pockets on heavy garments (shearling), if torn, should be reinforced with an ample patch made from cape leather, sewed separately to the shearling under the pocket and extending at least ½ inch above and on either side of the pocket. It is not necessary to extend the patch the full length of the pocket; 2 or 3 inches below the top is sufficient.

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(1) Cement (spec. 20–29) is used to cement small reinforcing patches made from cape or horsehide leather under glove fasteners as shown at (A), figure 42. It is also used to fasten insignia on flying clothing, leather strips on helmets, gauntlets, etc., and for cementing chamois skin to some types of helmet chin straps. Three thin coats of cement are applied to both surfaces, allowing 5 to 10 minutes between coats. There should be no wrinkles after cementing.

(2) Glove fasteners are attached to a small piece of leather as shown at (D), figure 42, which is then sewed to the material or garment as shown at (C). If sewed to the garment in this manner no metal will come in contact with the skin. This patch can also be sewed on three sides, forming a small pocket, which facilitates the use of the finger when using the fastener on bags, clothing, etc., where it is difficult to open and close them. Some fasteners are completely concealed as shown at (B).

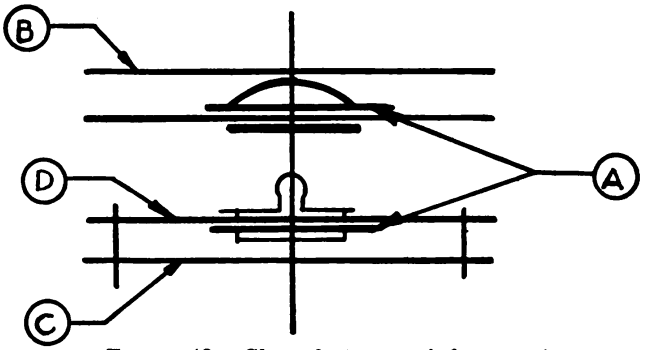

FIGURE 42.—Glove fastener reinforcement.

f. Replacing sections and relocating ear pads of helmets.—The binding strip is first removed very carefully. After removing the section to be replaced, it can be used as a pattern for the new one, or drawings can be used for this purpose. The section is sewed in place in the same manner as the original, but the old binding is discarded, and a new strip of leather, approximately 1¼ inches wide and of the same length as the original, is cemented in place before machine sewing. When relocating ear pads (powder puff), the edge of the pads should be located in the helmet so that the pressure will be only on the lower three-fourths of the ear. This eliminates the pressure caused by the headsets.

g. Attaching skirts and wristlets to jackets.—(1) The old skirt is carefully removed by ripping the seams and removing all cut machine threads. If a loose thread is allowed to remain, the new machine seam will appear as though the thread is cut and will not have a neat appearance. The first step when sewing on a new skirt

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is to sew the skirt at each end to the leather of the jacket. The garment is then stretched at the skirt the full length of the lining and outer shell, and pinned at intervals of about 3 inches to the lining only. This is done to distribute the gathers evenly. The lining and skirt are then machine sewed, using care to keep the gathers as uniform as possible. The second step is to attach the leather (outer shell), stitching and pinning as previously explained, except that sewing is on the outside of the garment, through all thicknesses of material, folding the leather back far enough to conceal the old needle holes before the seam is made.

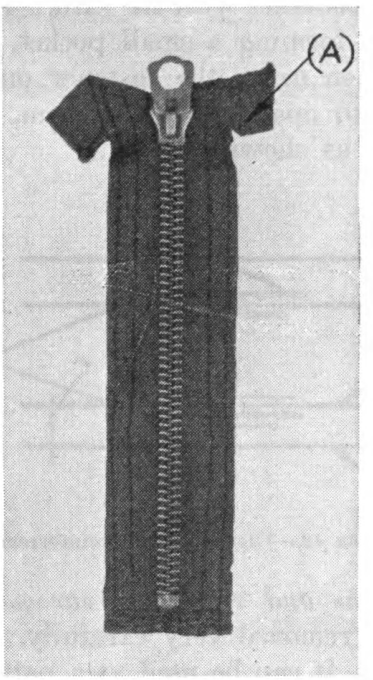

FIGURE 43.—Reinforcing tape and cord of fastener.

(2) The method of attaching and removing tubular knitted jacket wristlets is practically the same as for the skirt. The lining is pulled out of the sleeve far enough to sew to the wristlet. The wristlet is then placed inside the sleeve, approximately ½ inch from the edge, and stretched to fit the lining. The unsewed end of the wristlet is pulled out of the sleeve lining and sewed to the outer shell on the outside of the sleeve, dividing the gathers.

26. Assembly, attachment, and repair of interlocking fasteners.—*a. Assembly.*—(1) In measuring for the assembly of the fastener, it is necessary to allow between 1 and 1½ inches at each end of the seam for the attachment of parts, and the folding required for machine sewing. This allowance is shown at (A), figure 43. After

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the correct measurement is determined, the fastener may be cut to length and the allowance marked with a pencil at each end. The scoops lying beyond the marks may then be clipped off, one at a time, with end cutters as illustrated at (A), figure 44. Care must be used during this operation to avoid cutting the cords.

(2) Assembly of the slider is next accomplished as shown at (B), figure 44. The slider is held in one hand and the tape ends are gently pulled through it until the scoops begin to join. If the joining is not consecutive, the slider must be removed and the operation repeated.

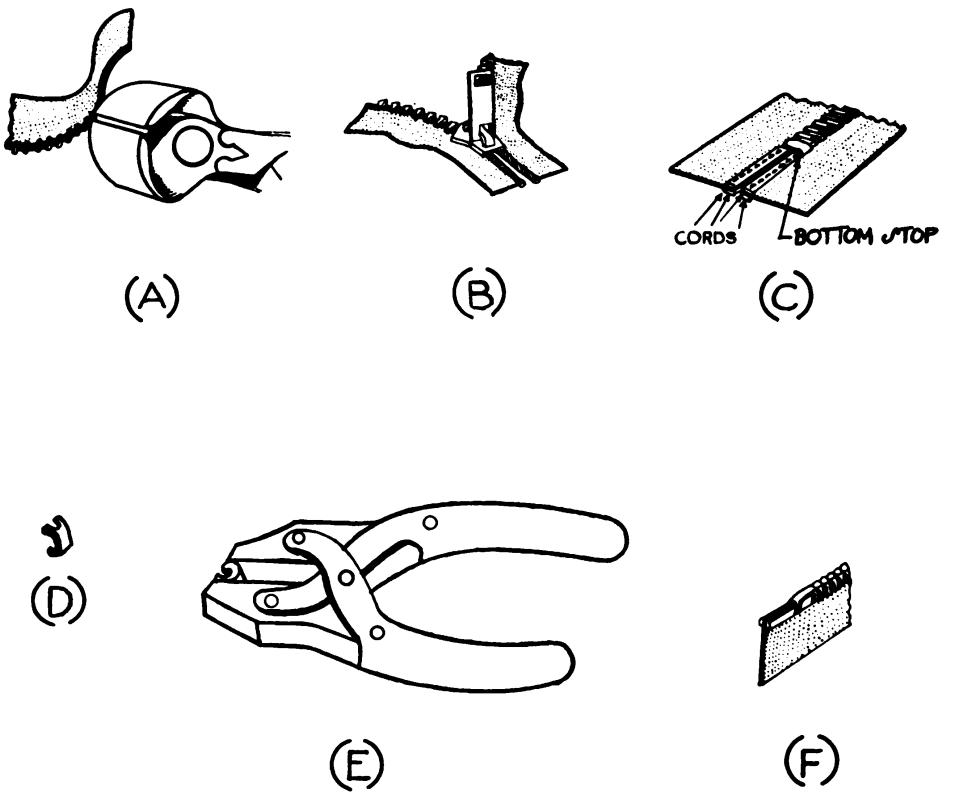

FIGURE 44.—Assembling interlocking fasteners and parts.

(3) With the slider in place the bottom stop is next attached, as shown at (C), figure 44, by crimping it securely over the cord with a pair of pliers.

(4) The top stops as shown at (D) are each installed in the following manner:

(*a*) Place stop (legs down) on a smooth surface and grip it gently with the pliers as shown at (E).

(*b*) Slip stop over cord, directly above last scoop, as shown at (F) and crimp in place, making sure that its legs straddle the cord.

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(*c*) Use care in installing the second stop so that it is located directly opposite the first.

(5) With the stops in place, the assembly is completed by folding the excess tape under and stitching it securely in place (fig. 43).

(6) The fastener is now ready for attachment.

b. Attachment.—The fastener is attached by means of a double row of stitches as shown in figure 43. To avoid uneven application, the fastener must be held taut while the material is allowed to feed freely.

(1) In order to keep both sides of the unit directly opposite, the fastener should be separated and one side sewed in place. The unsewed side may then be placed over the fabric and sewed into place

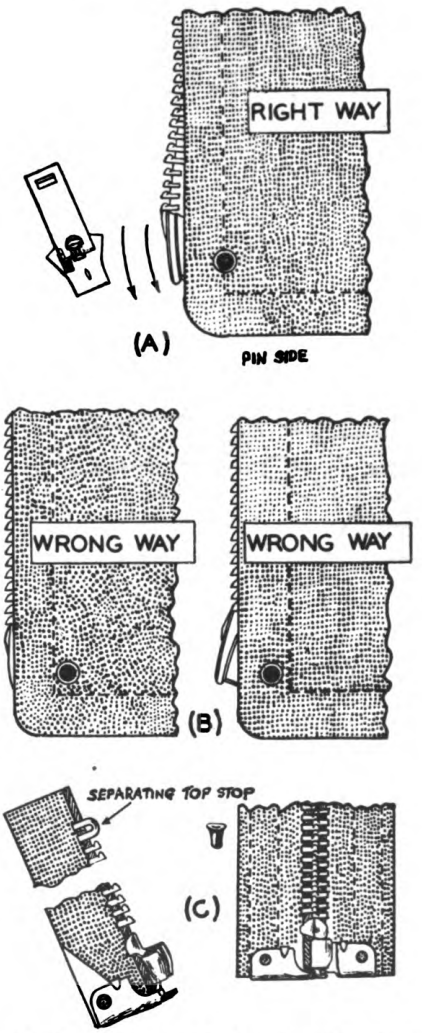

FIGURE 45.—Anchoring the ends of separating type fasteners.

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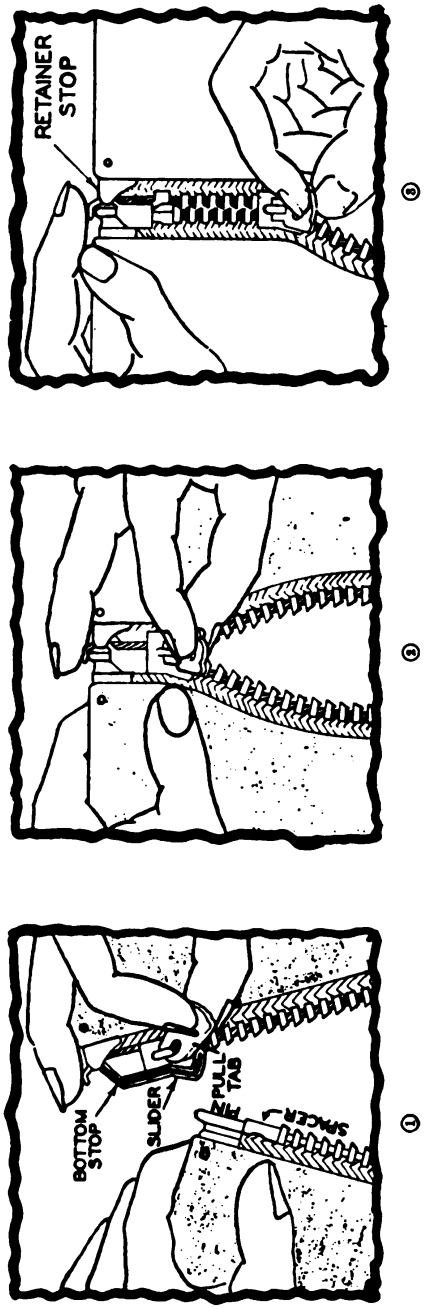

FIGURE 46.—Separating stop fastener.

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after several marks have been made along its length to form a guide for correct location.

(2) In the attachment of separating fasteners, the last 2 inches of the pin side must be shifted out slightly as shown at (A), figure 45, to allow for easy starting of the slider. Incorrect applications are shown at (B) and must be avoided.

(3) In machine sewing the bottom end of the separating fastener care must be used to prevent the needle from striking the metal section. Sewing through the hole of the pin or retaining stop should not be attempted with the machine, as these points may be anchored by means of an eyelet or by hand sewing. Properly applied ends are illustrated at (C), figure 45.

(4) The separating stop fastener (fig. 46) is used in place of the plain separating type when a closer and neater fit is desired. As shown in figure 46 ①, the separating stop is crimped and riveted to the lower end of the fastener with the pin and spacer on the left, and the bottom stop and retainer on the right. Attachment of the fastener is made in the same manner as previously described. In opening or closing this type of fastener the slider must be against the bottom stop and parts held as shown in figure 46 ②. This fastener must never be pulled apart without first lifting the pull tab to an upright position (fig. 46 ③).

(5) Inserted fasteners, when applied to openings in covers, panels, etc., are attached to the underside of the material at the point where the opening is to be made. This is done by machine sewing around the outer edge (fig. 47 ①). The fastener is placed with the pull-tab against the material and, when the seam is completed, the cover is slit to form the opening as shown in figure 47 ②. The installation is finished by folding the edges of the cover under, approximately ⅜ inch, and sewing in place (fig. 47 ③).

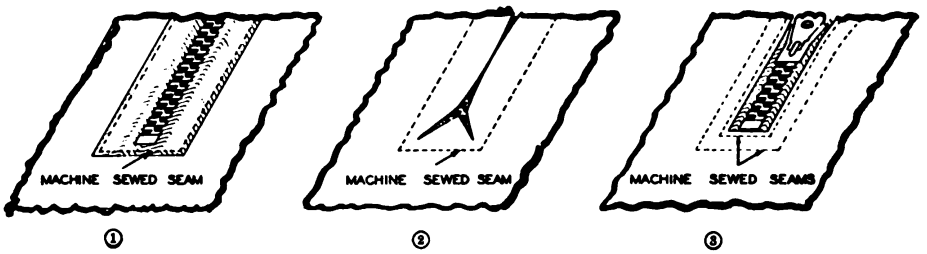

FIGURE 47.—Inserting interlocking fastener.

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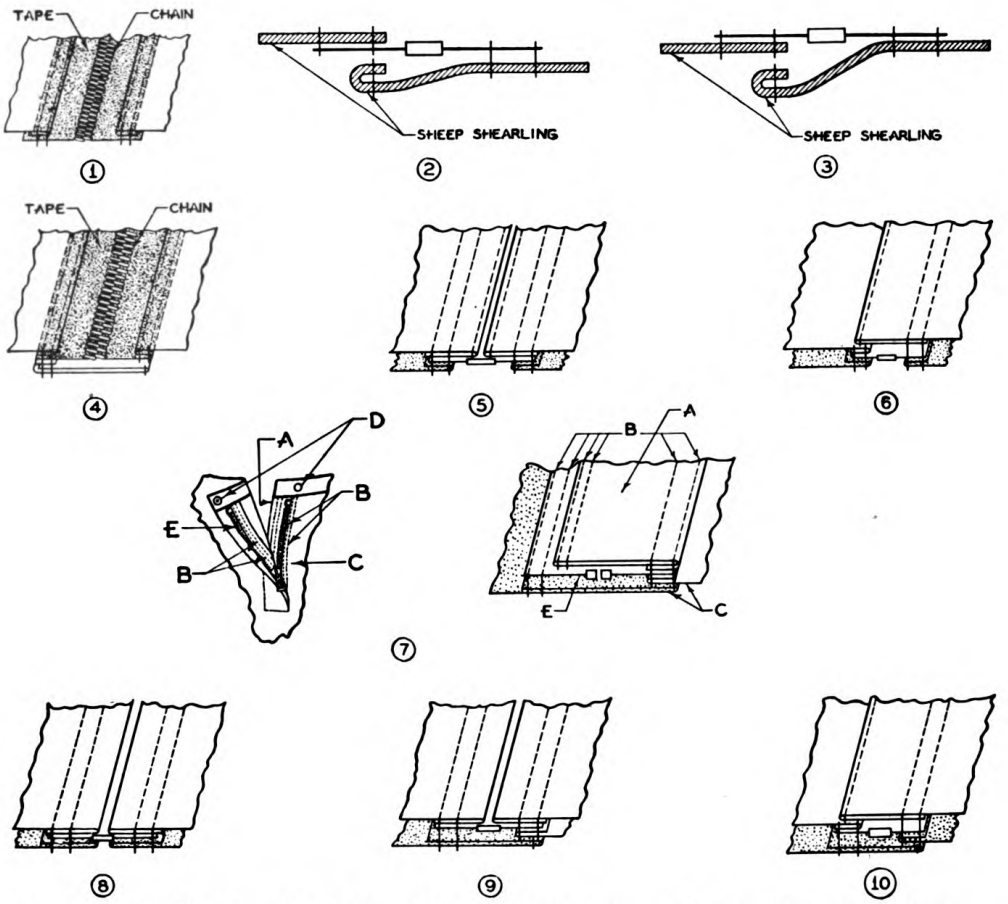
(6) In right angular and similar openings, two complete fasteners are required. Attachment is made with each fastener placed to open out from the intersection.

(7) Circular openings require special interlocking fasteners which are installed in the same manner as the straight type.



1. Visible. 2. Visible, single plait. 3. Visible, single plait. 4. Visible, single plait. 5. Concealed, single plait. 6. Concealed, single plait. 7. Concealed, double plait. 8. Concealed, double plait. 9. Concealed, double plait. 10. Concealed, double plait.

FIGURE 48.—Types of seams used for attaching interlocking fasteners.

(8) The various seams used in the application of interlocking fasteners are shown in figure 48.

(9) If an extension is desired on an interlocking slider it may be made from leather using the measurements given at (A), figure 49. The method of looping the leather in the hole of the metal pull tab is shown at (B).

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c. Repairs.—Damaged fasteners are generally the result of improper attachment, careless handling, or overloading due to the use of too small a fastener. The following recommendations for repair and replacement apply to the various types in general use:

(1) Where fasteners separate behind the slider (fig. 50 ①), the slider jaws have been spread apart and a new slider must be installed.

(2) Jamming of the slider is generally caused by loose threads, cloth, or dirt being caught between the slider and scoops (fig. 50 ②). The slider should be gently worked back to its open position and the obstruction removed. If the slider jaws have been sprung out of shape, a new slider must be installed.

(3) In the case of loss of the top or bottom stops, the cords must be carefully inspected and, if found to be in good condition, new stops may be crimped in place. In case the cord has become frayed (fig. 50 ③), several scoops must be clipped off and the stop crimped onto the resulting exposed cord.

(4) When scoops have been ripped off (fig. 50 ④) the fastener must either be shortened to eliminate this section or replaced entirely.

(5) Split tape indicates the use of too light a fastener and the unit should be replaced with a heavier one.

(6) Broken separating components at the bottom of the separating stop type of fasteners require replacement of the entire unit.

27. Manufacture and maintenance of fabric equipment.—*a. General.*—The methods used in laying out, manufacturing, and repairing fabric equipment depend entirely upon the type and shape required. When possible, drawings should be consulted for details, although in many cases such drawings will not be available. The old cover should always be used as a guide in making the new one, and in some cases it will be found necessary to make a drawing from which paper patterns may be cut. When sewing large panels, covers, etc., where a lap seam, such as shown in figure 23, is to be exposed to the weather, the external edge of the seam should be toward the bottom (unless vertical) to allow water to flow over the seam without obstruction.

b. Panels or covers.—The first step in manufacturing panels or covers is to determine the length of each strip, and the number of strips required. The length of the strip is measured in feet, while the number of strips is obtained by dividing the width of the panel by the width of these strips. The standard width for cloth and duck is 36 inches, while that of artificial leather is 50 inches. In the calculation, allowance must be made for the seams. For the average

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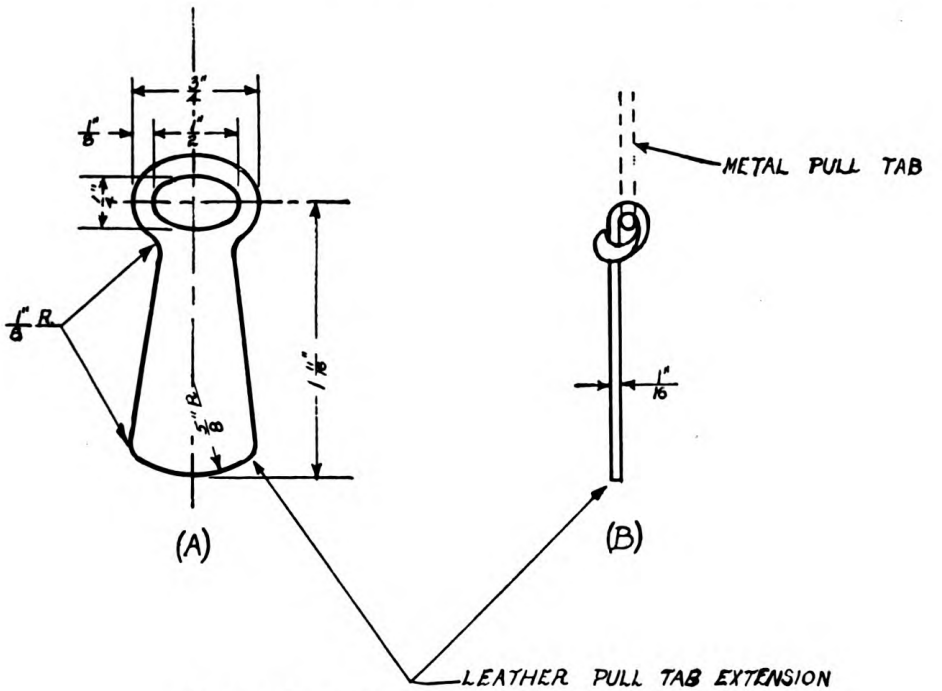

FIGURE 49.—Leather pull tab extension for fastener.

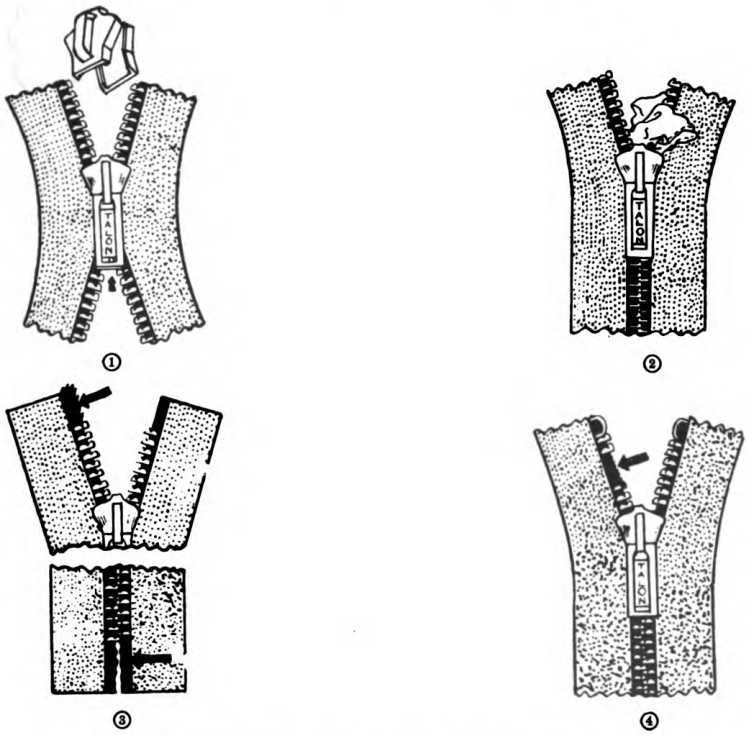

FIGURE 50.—Interlocking fastener repairs.

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size hem where fasteners are to be used, 1½ to 2 inches must be allowed in both length and width. Covers that are to be left attached while the airplane is in flight should be made so that the warp threads are parallel to the air stream.

(1) If stiffener frames are to be placed in covers an extra piece of material approximately 3 inches larger than the frame must be laid over the top of the cover at the position desired, and the inside of the frame marked off on the patch (fig. 51 ①). The patch is then

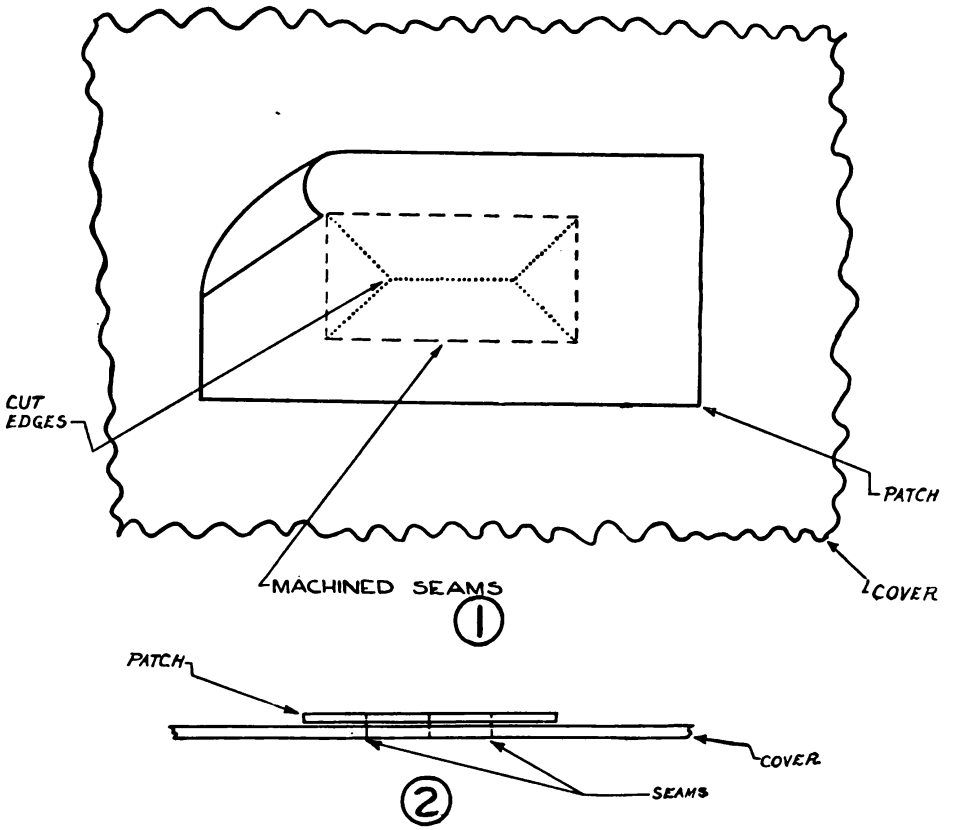

FIGURE 51.—Reinforced opening or buttonhole.

carefully machine sewed along the pencil mark, and the material inside the seam cut out, allowing a ⅛-inch margin all around. The 3-inch flap is turned to the opposite side, the frame put in, and the flap pinned to the cover, allowing no wrinkles to remain. A machine seam is then made as close as possible to the frame along the outside edge of the flap.

(2) The tailored buttonhole is used for small openings on clothing, covers, panels, bags, etc., where grommets or eyelets are not practical. The buttonhole is made in the same manner as the rein-

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forced opening, except that the metal frame is not used and a smaller patch is required (fig. 51 ②).

c. Cockpit covers.—In order to obtain the proper measurements for material, as well as for ease in attachment, lift-the-dot posts of the machine screw type are installed around the cowling approximately ½ inch from the upholstering. The first post is placed on the center line of the cockpit at its leading edge, as shown at (A) figure 52. The next post is installed on the center line at the back of the cockpit, as shown at (B), and the other posts placed at intervals of 6 to 7 inches between them. With the posts in place, the measurements may be taken for the material and the necessary allowance made for the seams and hems. A type LSc–2 seam (fig. 26 ②) should be used, although no seam will be required in many cases, due to the narrow width of the cockpit. The material is then placed over the cockpit, with the warp threads parallel to the line of flight. In

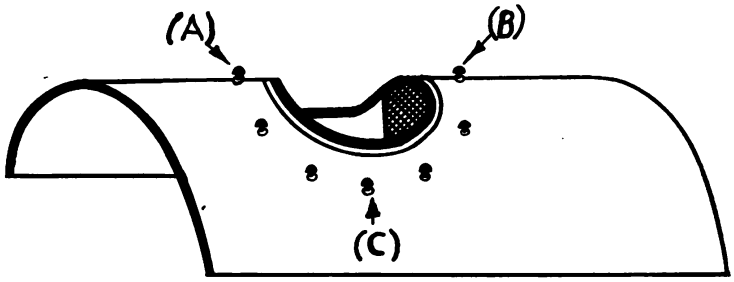

FIGURE 52.—Installation of cockpit cover.

order to obtain a cover free from puckers or wrinkles, a hole is punched in the front of the piece to hold it temporarily in place on the post located at position (A), figure 52. The cover is then pulled just enough to keep it taut, and a hole punched in the cover for the post located at (B). The next hole is punched at (C) and is followed by one at the same location on the opposite side of the cockpit. Care must be taken to prevent pulling the warp too tight as it must be kept parallel with the line of flight. The remaining holes may then be punched, alternating from side to side. When all the holes have been punched the cover is removed and a line is drawn around its edge, clearing the holes by ¾ inch. The material is folded and stitched on this line, using a type EFb–2 stitch (fig. 36 ②). The holes that are punched in the cover indicate the points for the installation of the lift-the-dot fasteners. The lift-the-dot on the fastener sockets are placed at the outside edge of the cover as they will operate in no other position.

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d. Luggage compartments.—(1) The measurement of luggage compartments is often difficult because of the wide range of types employed. If blueprints cannot be secured or the old luggage compartment is not available, paper patterns must be layed out and the compartment made from them.

(2) Baggage compartments are usually secured in place by grommets, eyelets, or clamping devices, while the opening is often made by means of an interlocking fastener.

e. Engine covers.—In the lay-out of an engine cover a sketch should be made showing the diameter, circumference, and width of the engine. Careful judgment must be used in making the opening so the cover can be taken off or put on easily. The cover must fit snugly so that it cannot be blown off by the wind. Proper security may be obtained by the careful application of glove, lift-the-dot, or turn-knob type fasteners.

f. Boots or socks.—Duck is used for all outside types of boots or socks, while either airplane fabric or duck may be used for the inside type. They are attached either by lacing, through grommets, or by stitching, using the type EFb–1 stitch (fig. 36 ①). A boot or sock is used for protection against dirt and grease on such units as tail post fittings, rods, etc.

g. Bomb-bay curtains.—Owing to the many projections encountered, extreme care must be taken in making this curtain. Where possible the old piece should be used as a pattern, although if not available, a paper pattern may be cut. If the material requires piecing, the type LSc–2 or LSc–3 lap seams (fig. 24) are used. The outside edges of the curtain are stitched and all projection holes are reinforced with russet or horsehide leather. Number 0 or 2/0 grommets are placed at 2 inch intervals in the hem for lacing to the bomb bay. Interlocking fasteners with double pull sliders are often used for required openings.

28. Manufacture and maintenance of leather equipment.—In manufacture and maintenance, certain principles should be kept in mind, that is, if drawings are available they should always be consulted, but if not the old cover, etc., should be used as a pattern. When working with artificial leather, the temperature should be approximately 70° F. If temperature is too low the finish has a tendency to crack.

a. Crashpads.—The various types of crashpads are manufactured from artificial leather, horsehide, duck, etc., and padded with either felt, sponge rubber, upholstering hair, or kapok. Attachment is made by lacing or clamping between metal strips, held in place by machine

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screws. If kapok is used, it is best to provide an airplane fabric lining to confine the padding in case a seam is ripped.

b. Blind flying cockpit hoods and compartments.—Blind flying cockpit hoods are made from the same materials as crashpads.

(1) One method of construction employs collapsible staves that extend above the cockpit in a circular shape. The staves are first bolted at the hinge and adjusted to the desired location on the cockpit. After the staves have been equally spaced from front to rear, they should be tied in place with a cord and a paper pattern cut and fitted over them as a guide in making the cover. The cover may then be cut out and placed in position and the location of each stave marked on its under side. The whole assembly is then removed from the cockpit and strips of webbing or other similar material are sewed onto the cover to enclose each stave. The cover is held to the cockpit with lift-the-dot fasteners and a release catch which is attached to the front stave.

(2) Some hoods are secured by special interlocking fasteners using the double pull slider. These hoods are made in the same manner as the cockpit cover previously described. After the cover is fitted into place, the special interlocking fastener is properly located, pinned or marked, and sewed in place.

(3) Cabin type airplanes require small panel inclosures for use in blind flying. The panels are held to the inside structure with lift-the-dot or glove fasteners and either artificial leather or duck may be used in their construction.

c. Upholstering cockpit cowlings.—Materials used for upholstering cowlings are artificial leather, horsehide, etc., and the padding may be upholstering hair, felt, or kapok. Drawings are not usually available for this type of work, and it is therefore advisable to use the old upholstering as a pattern. If this is not available, a paper pattern must be made. When artificial leather is to be used it should be cut on the bias so the edges will stretch more easily while lacing to the cowling. When the upholstering is to be padded with upholstering hair, the tools, described in paragraph 15*c* (3) and (4), are used for stuffing and smoothing the upholstering. Lacing is accomplished by means of rawhide or linen shock absorber cord through grommets or eyelets attached to the cover. When cord is used for this purpose, it should be double threaded.

d. Life preserver cushion.—Life preserver cushions are made from artificial leather, horsehide, etc. The color specified for these cushions is yellow (the brightest color obtainable for light reflection).

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Drawings are usually available for the various types of cushions although if not obtainable, measurement may be taken directly from the airplane seats. The cushions must be provided with an adjustable belt made from 1½-inch heavy webbing for attachment around the body or armhole straps. The first step in making the cushion,

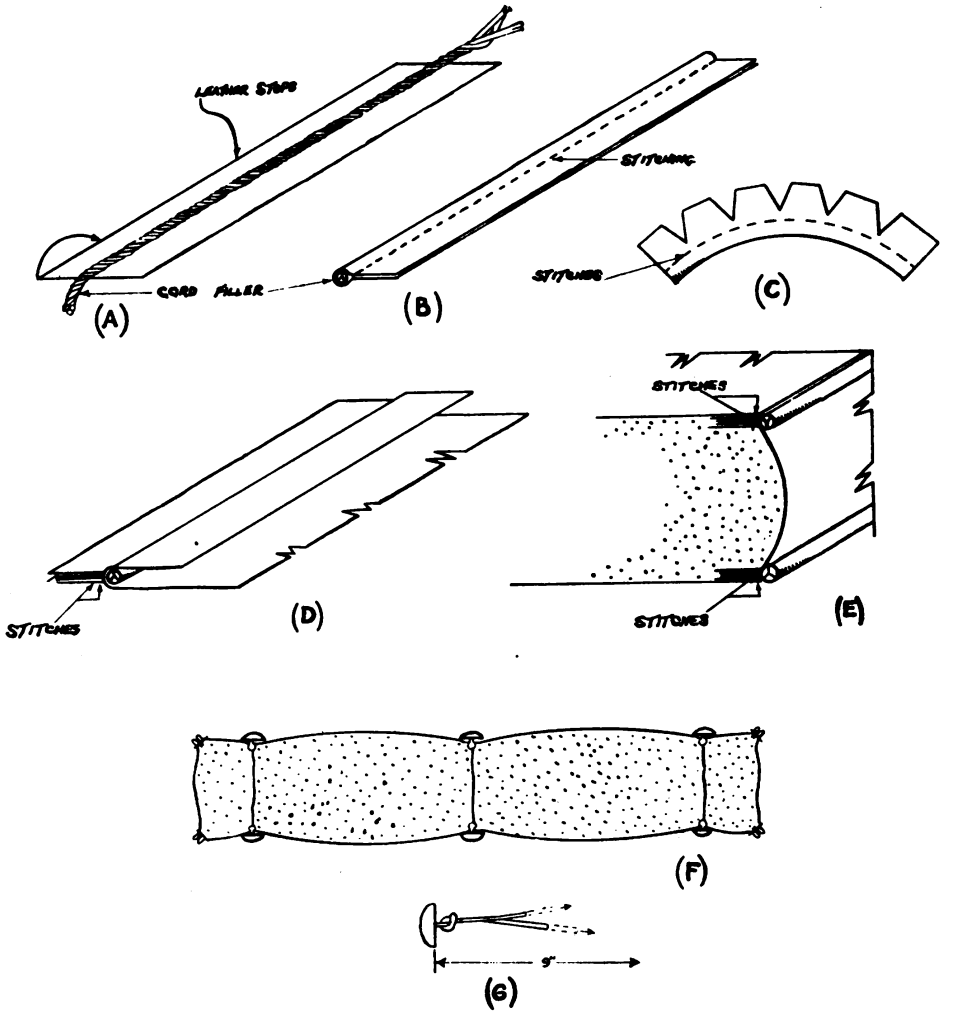

FIGURE 53.—Cushion assembly.

after the design has been determined, is to cut two strips of leather 1½ inches wide and long enough to extend around the cushion. A heavy cord (shock absorber, serving, or blocking) is laid along the center of the leather strips as shown at (A), figure 53. The leather strips are then doubled over and sewed as close to the cord as possible, as shown at (B), to form a beading. When making this beading to fit a radius or corner the edges of the leather are cut as

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shown at (C). The top and sides are then cut to size and sewed to the beading as shown at (D). The bottom is next sewed to the side to form an assembly as illustrated at (E). One seam is left open for approximately 6 inches at the end for turning the cushion right side out and stuffing. The cushion is then filled with kapok and the opening sewed up by hand. All unexposed stitches are required to be of the double lock type and the type SSe–2 seam is often used. Upholstering buttons are attached to the top and bottom of the cushion to hold it in shape as shown at (F). Waxed linen cord is used for lacing the buttons in place. It is cut in 18- to 24-inch lengths and looped through the eye of the button as shown at (G). A long, straight, sail-maker's needle is used to carry the cord to the opposite side where it is fastened to the opposite button with a square knot. The thickness adjustment of the cushion is made by tightening the first loop of the square knot. After all buttons are properly adjusted the knots are finished and the cord ends cut off.

e. Safety belts.—(1) Pilots' belts of standard length cannot always be shortened sufficiently by the strap adjustment to fit all individuals properly. In such cases, the belt may be fitted by overlapping and stitching the webbing as follows:

(*a*) With the belt properly attached to the airplane and buckled to the individual, reduce its length to the minimum by means of the strap adjustment on each side. Leaving the belt fastened in place, ascertain the desired length by overlapping the webbing an equal amount, on each side, near the buckle. The minimum lap will be 1 inch and, if this shortens the belt more than is required, the desired length may be obtained by the strap adjustments. With the overlap marked at the proper point, remove the belt from the airplane and securely machine or hand stitch the laps in place. Five-cord linen thread, specification V–T–291, is used for this purpose and the stitching should extend around the four edges of the lap as well as diagonally across it.

(*b*) Belts shortened as described in (*a*) above should be kept with the airplanes for which they were prepared.

(2) Cotton webbing safety belts that have been in salt water must be thoroughly rinsed in fresh water, dried, inspected, and tested immediately to determine whether or not they may be replaced in service. If found to be satisfactory, neat's-foot oil should be thoroughly rubbed into the leather to keep it soft and pliable.

29. Knots, splices, etc.—A number of knots, splices, bindings, etc., are used in the manufacture of fabric and leather flying equipment.

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The making of these fastenings, along with their common uses, is explained in *a* to *i* below.

a. Splice knot.—When it is necessary to splice cord or rope while lacing covers, panels, etc., the splice knot (fig. 54) is tied in the following manner:

(1) Cross the ends of the cord or rope as shown in figure 54 ① and wrap the small end of the free piece (a) around the end of the standing piece (b) three complete wraps, then double it back through the formed loop as in figure 54 ②.

(2) Wrap the other free end (d) and double it back as shown in figure 54 ③.

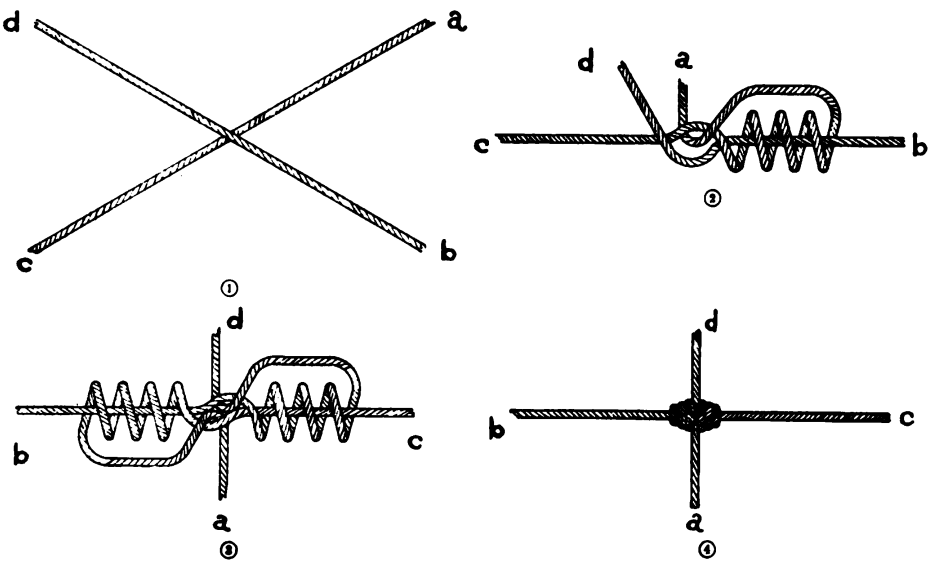

FIGURE 54.—Splice knot.

(3) Pull the two long ends of the cords (b) and (c) until the knot is tight (fig. 54 ④) and cut off the short ends close to the knot thereby completing the operation.

b. Whipping.—Binding the ends of a rope or cord with thread so that it will not unravel is called whipping. This operation is shown in figure 55 and is accomplished as follows:

(1) Secure a piece of thread about 3 feet long and place it on the rope, allowing the end (a) to hang loosely over the end of the rope.

(2) Make a loop by passing the opposite end of the thread (b) down the rope and allowing a loose end of about 2 inches as shown in figure 55 ①.

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(3) Grasp the rope with the left hand in such a manner that the thumb can be placed on both threads. With the right hand, grasp the loop of the thread at (c) and wrap it down the rope, over itself and the other strand as shown in figure 55 ②.

(4) Continue the wrapping as far as desired (½ inch or more) then draw up the loops and tighten by pulling on the ends (a) and (b) as shown in figure 55 ③.

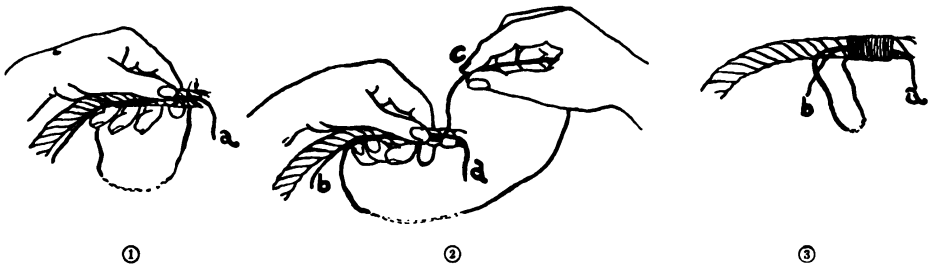

FIGURE 55.—Whipping.

(5) Cut off the ends close to the whipping and the operation is complete.

c. Binder knot (fig. 56).—This is the simplest method of joining two threads, cords, or ropes and is made by placing the two ends side by side and tying an overhand knot. It will not slip and, when tightly drawn, is difficult to untie.

FIGURE 56.—Binder knot.

d. Bowline.—This knot is used for fastening the pilot parachute attaching cord (bridle line) around the suspension lines at the apex of the canopy and for attaching the pilot chute to the bridle line. The knot (fig. 57) is tied in the following manner:

(1) With the right hand on the end of the cord and the left hand on the standing part (fig. 57 ①), make a loop with the left hand, around the end of the cord (fig. 57 ②).

(2) Hold the loop in place with the left hand and, grasping the end of the cord with the right hand, bring it through the loop (fig. 57 ③ and ④).

(3) Tighten by pulling the free end snug, completing the knot.

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e. Crown knot.—The crown knot is, in itself, a complete and permanent fastening, and is very important as the basis of rope and cord end splices. The procedure for making this knot is given below and the necessary steps are shown in figure 58.

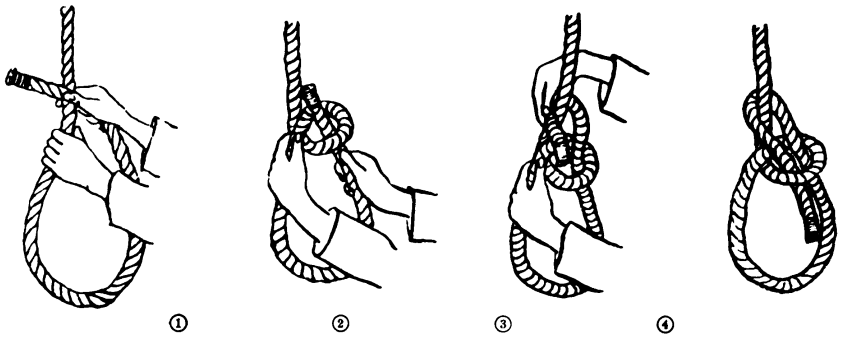

FIGURE 57.—Bowline.

(1) Unlay the end of the rope for several inches, and bring strand (a) down between strands (b) and (c) forming a loop (fig. 58 ①).

(2) Pass strand (b) across this loop so that it will lie between the loop and the strand (fig. 58 ②).

(3) Pass strand (c) through the first loop (fig. 58 ③).

(4) Finish crown by tightly pulling each of the strands.

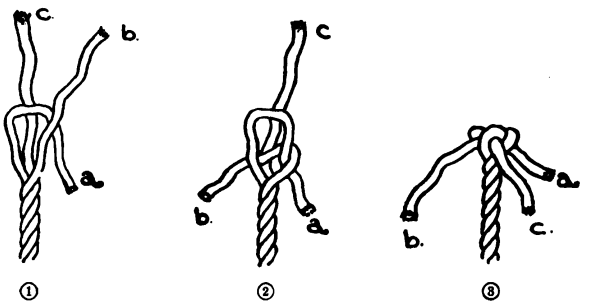

FIGURE 58.—Crown knot.

f. End of crown splice.—As shown in figure 59, this is a permanent fastening on the end of a rope or cord to prevent its unraveling and is a continuation of the crown knot shown in figure 58.

(1) Assuming that the crown knot has been made, pass strand (a) back under the nearest strand (1) and over the second strand (2) (almost at right angles to the twist of the strands) as shown in figure 59 ①.

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(2) Repeat this procedure with strands (b) and (c), ((b) over (2) and under (3) and (c) over (3) and under (1)), using a marlin spike as indicated to form the openings.

(3) Continue tucking ends (a), (b), and (c) as shown in figure 59 ②, making a smooth, tapering splice by cutting out a portion of the fibers of the strands after each tuck.

(4) When finished, pound the splice lightly with a short stick or hammer and roll it on the floor under the foot or a block.

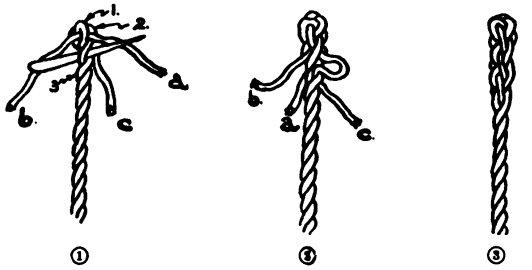

FIGURE 59.—End or crown splice.

g. Wall knot (fig. 60).—Among the rope or cord end fastenings that are easily and quickly made, the wall knot is the most commonly used. The following procedure applies particularly to small ropes and cords:

(1) Unlay the strands for about 3 inches and hold the rope or cord in the left hand with the loose strands upward.

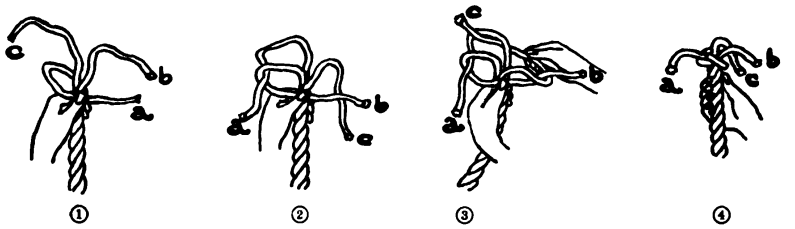

FIGURE 60.—Wall knot.

(2) With the right hand, grasp the end of strand (a) and bring it across the rope, forming a loop and holding it in position with the left thumb (fig. 60 ①).

(3) Grasp strand (b), pass it under strand (a) (fig. 60 ②), and hold it against the rope with the thumb of the left hand.

(4) With the right hand, grasp strand (c), pass it under strand (b) and up through the first loop formed, as shown in figure 60 ② and ③.

(5) Draw each strand up gradually until the knot is tight (fig. 60 ④), completing the operation.

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h. Square knot (fig. 61).—The square knot is made by first tying a simple overhand knot (fig. 61 ①) and then locking it with a second overhand knot tied so that the free ends leave the loops on the same side as the standing parts. The completed knot is shown in figure 61 ②.

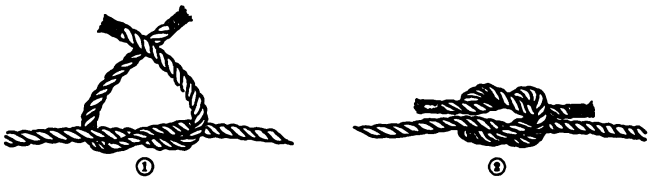

FIGURE 61.—Square knot.

i. Surgeon's knot (fig. 62).—The surgeon's knot is similar to the square knot, except that the first overhand is wrapped twice instead of once around the cord or rope. This knot may be used in place of the square knot where more strength is required.

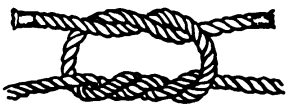

FIGURE 62.—Surgeon's knot.

30. Installation of headsets on helmets.—*a.* A change in the position of the ear cups and location of the keepers for the headset cord on helmets is frequently required. The position of these parts on the helmet is shown in figures 63 and 64 and the usual methods of making these modifications are as follows:

(1) Place the helmet on the head of the individual to be fitted and locate the center of each ear, indicating these centers with pencil marks on the outside of the helmet. Be sure that the helmet has not been pulled to one side of the head and that the chin strap is buckled so as to obtain normal tension. When ear puffs are used the pencil marks do not necessarily fall directly over the center of the ear puffs as the latter must be located so as to eliminate pressure on top of the ear. Helmets lined with lamb shearling require no ear puffs. Some types with fabric or leather lining have disks of lamb shearling that can be installed when ear puffs are required.

(2) Remove the helmet from the individual's head and punch a ¾ inch hole through the outside leather and the lining on each side of the helmet, using the pencil marks that locate the center of the ear as the center of each hole.

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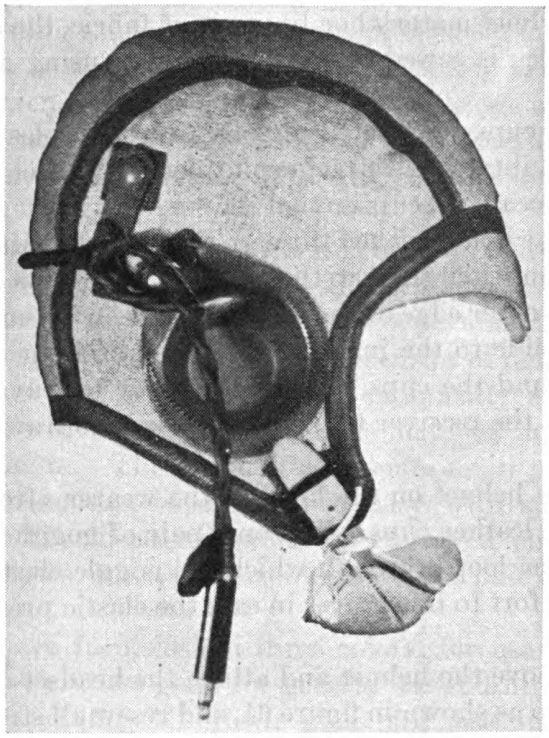

FIGURE 63.—Installation of headsets on helmets.

FIGURE 64.—Installation of headsets on helmets.

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(3) If the helmet material or lining is of fabric, the edge of each of the ¾ inch holes is sewed to prevent fraying using a "button-hole" stitch.

(4) Receiver cups are located directly over the holes punched in the helmet. To facilitate this attachment, place a headset receiver within each cup, then locate the cups so that the six holes in the receiver cap are centered over the hole punched through the helmet. Mark the position of each cup, then stitch them to the helmet. Two rows of stitching are used, one at the outer edge of the leather flange on the cup and the other as near as possible to the inner edge. The stitching is not extended completely around the cups, as it is necessary to leave sufficient free space to permit the receiver to be inserted or withdrawn from the cup at any time.

(5) Place the helmet on the head of the wearer after inserting the receivers in the leather cups. Try on a pair of goggles, and, if necessary, relocate the loops through which the goggle elastic passes, so as to avoid discomfort to the wearer in case the elastic presses against the ear cups.

(6) Next remove the helmet and attach the headset cord keepers on each goggle loop as shown in figure 64, and resew all stitching removed in reworking the helmet. Also mark the proper locations for the glove-fastener parts to correspond with the fasteners attached to the leather cups. A small piece of thin leather is placed over the base (eyelet) of each fastener post for reinforcing the helmet material at these points.

(7) If the cord connecting the two receivers is too short for comfort, a slightly additional length may be secured by drawing the receivers apart and causing the tie-cord knot to slip a slight amount. Each tie cord may be slipped approximately ¼ inch, but care must be taken that all the strain between the receiver and the cord is still taken by the tie cord and not by the conductors and terminals.

31. Adjustment and alinement of goggles.—Goggles are usually of two types, differing only in the construction of the bridge and in the method of locking the lenses and cushions in place.

a. Nose adjustments and replacement of lenses and cushions are accomplished as follows:

(1) In the first type, the nose adjustment is made by removing the hinge pin in the bridge with a screwdriver and replacing the pin in the desired hole. Lenses and cushions are replaced by removing the headband and sliding off the knurled collar.

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(2) A slightly finer adjustment is possible in the second type and is made by loosening the long knurled sleeve between the eye cups. The cups may then be separated the required distance and locked in position by retightening the sleeve. To replace lenses and cushions, the headband is removed and the perforated knob turned half a turn to open the hinge clamp. This clamp is located on the temple side of the frame.

b. For the prevention of eyestrain it is necessary that the frame hold the lenses in correct alinement. If the bridge is twisted or bent so that the cylindrical axes of the lenses are not parallel, the frame must be returned to the depot for repair or replacement of defective parts.

c. The lenses are designed to have practically zero power when in the normal wearing position, and are matched in pairs for power and verticle prism. The permissible variations in power for the acceptance of lenses can be determined only with special measuring instruments. The measured power is engraved on the lens, using numbers, triangles, etc., each lens of a matched pair bearing identical markings.

(1) Lenses are furnished in three colors, for use as follows:

(*a*) *Clear.*—Colorless glass for general use and night flying.

(*b*) *Amber.*—Yellowish-brown glass for use in hazy weather. This glass increases contrast and glare, and gives better visibility through haze and fog, but is not recommended for use in bright sunshine.

(*c*) *Antiglare.*—Sage-green glass for protection against glare, for use on bright days, over water, sand, or snow.

(2) Lenses will fit standard type of goggle frame. However, they must be issued only in matched pairs. Single lenses should be returned to stock and wrapped individually in tissue paper. Pairs having identical marking and color type are then selected from such accumulated lenses for reissue. Lenses are inspected before installation, and chipped places, scratches, or small air pockets (bubbles) are causes for rejection.

d. When installing new cushions, the locating pin in the nose side of the frame is engaged in the hole in the cushion retaining ring.

e. Goggle cushions occasionally become stained by the formation of copper sulphide. This is the result of the chemical action of the sulphur in the rubber on the copper retainer ring, and may be corrected by thoroughly scrubbing the cushion with a bristle brush, using soft soap, specification 18001, and lukewarm water. When

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clean, rinse in clear running water and dry thoroughly. To prevent further corrosion of the copper, paint the exposed surfaces of the metal retainer ring with varnish spar, water-resisting specification 3-136.

SECTION IV

CONSTRUCTION OF PARACHUTES

	Paragraph
General	32
Canopy	33
Pack	34
Harness	35
Flyer's kit bag	36

32. General.—The instructions in this section pertain to the conventional, circular type parachute. The complete parachute assembly consists of three major units, the canopy, the pack assembly, and the harness. These units are manufactured in various types and sizes, depending upon the purpose for which they are to be used. The following list shows the various types of parachute assemblies, together with other pertinent data:

Type	Description	Diameter in feet	Weight of wearer
S	Seat, service, small	24	Under 180 pounds.
S	Seat, service, large	28	Over 180 pounds.
T	Training (double)	22 and 28	No limitation.
B	Back, service	24	No limitation.

33. Canopy.—*a. Construction.*—(1) The canopy, which is constructed of high-grade silk fabric, constitutes the lifting surface of the parachute assembly, and as shown in figure 65 has a framework of cords, known as suspension lines, by which the load on the parachute is suspended. These lines vary in number, depending upon the size of the canopy. Each line extends from a connector link on one side of the harness riser to the skirt of the canopy, thence through a channel in the silk covering, entirely across the surface of the canopy to a point on the skirt diametrically opposite, and continuing to the riser on the other side of the harness. This permits each line to be a continuous length from one side of the harness to

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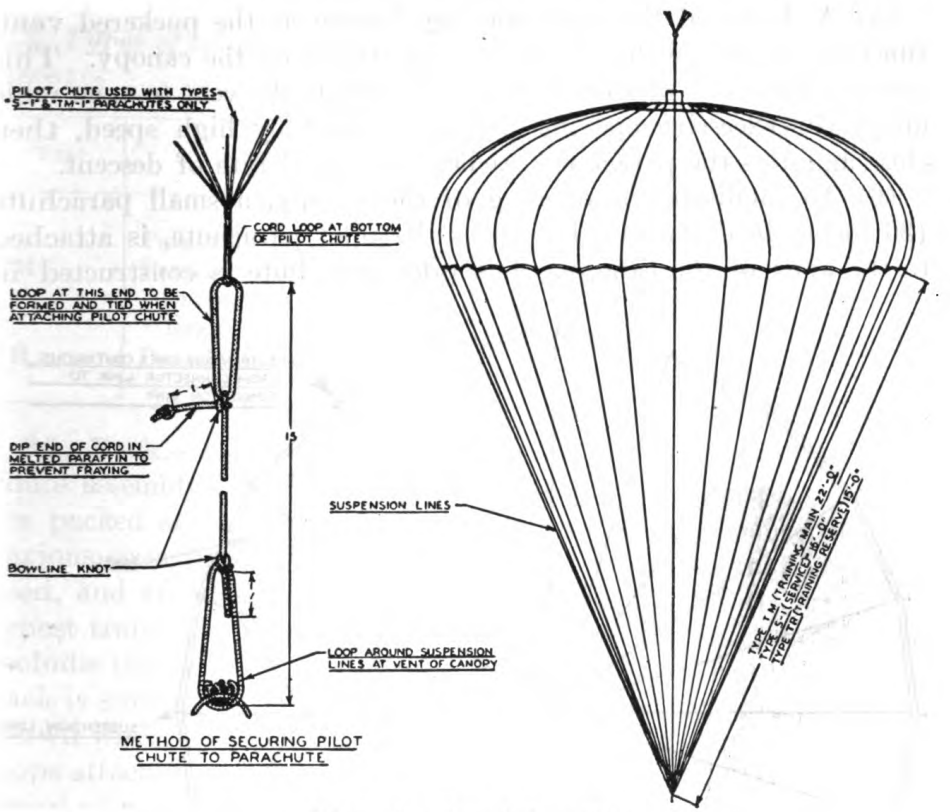

FIGURE 65.—Parachute cording.

the other. The lines cross each other at the apex of the canopy as shown in figure 66.

(2) That part of the canopy between any two suspension lines is known as a panel.

(3) The panels are further subdivided into sections. The silk of each section is cut on a bias, as shown in figure 66, with the warp of the fabric running at a 45° angle to the centerline of the panel. This arrangement not only permits greater economy in cutting the fabric, but also prevents any runs or tears from extending beyond the seams that are formed by joining the sections together.

(4) Completely encircling the panels at both the skirt and apex of the canopy are bands of 300-pound capacity, reinforcing silk tape. These are known as lateral bands, and serve to reinforce and strengthen the body of the canopy. The apex is reinforced with two thicknesses of this tape in the hem to compensate for the heavy strain imposed on it when the parachute is opened.

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(5) A device at the apex opening, known as the puckered vent, functions to relieve the initial opening strains on the canopy. This operates by means of an elastic, which permits the vent to open wide under the excessive opening pressure caused by high speed, then close again as the parachute reaches its normal rate of descent.

(6) To facilitate the opening of the canopy, a small parachute (36 inches in diameter), known as the pilot parachute, is attached to the apex of the canopy. The pilot parachute is constructed in

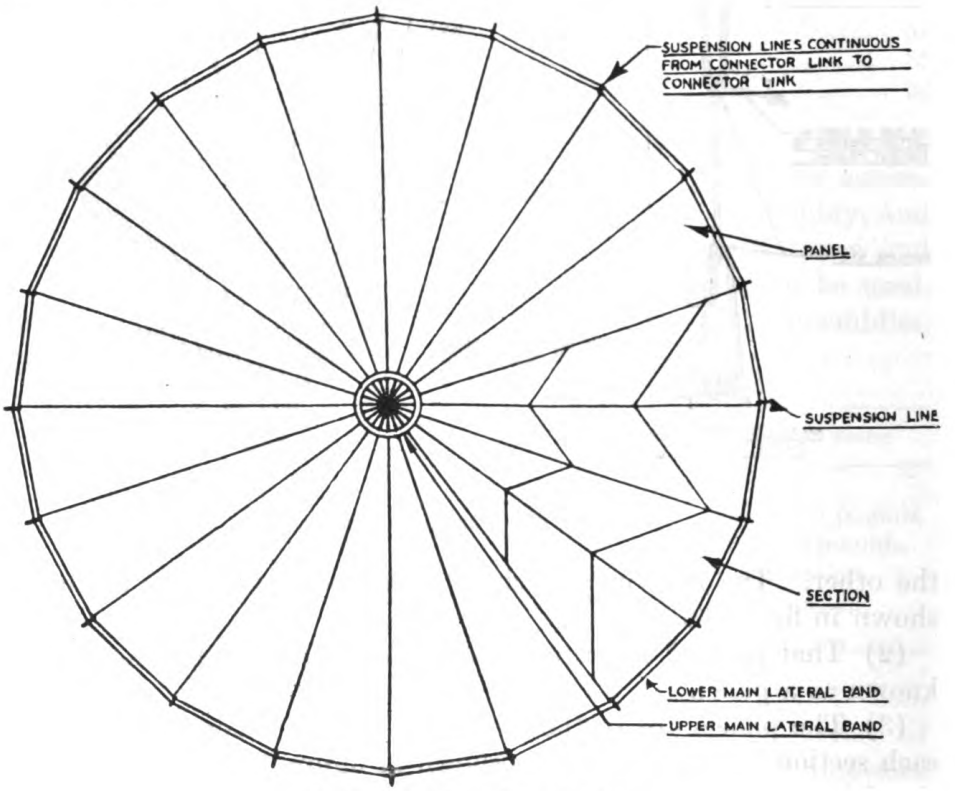

FIGURE 66.—Parachute canopy.

much the same manner as the main canopy, except for the inclusion of a spring-operated quick-opening device. When the ripcord is pulled, the pilot parachute is projected into the airstream and immediately filled with air, drawing the main canopy out of the pack and into position for opening. While the canopy will open without the assistance of the pilot parachute, the opening is slower and not as positive.

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b. Types of canopies.—Canopies are manufactured in the following sizes:

Type	Description	Diameter in feet	Rate of descent (feet per second)	Used with packs, types
S	Parachute, service, small	24	16 to 24	S or B.
TM	Parachute, training, main, or parachute, service, large.	28	14 to 20	S or BT.
TR	Parachute, training, reserve	22	17 to 26	CT.

34. Pack.—*a. Construction.*—The pack is that part of the parachute assembly in which the canopy and its folded suspension lines are packed and carried. Packs are fabricated of 12-ounce duck in various sizes, depending upon the purpose for which they are to be used, and are classified as follows: "S" (seat), "B" (back), "CT" (chest training), and "BT" (back training). The classification also includes the size of the canopy that it will contain. The bottom of the pack is semirigid in construction, being reinforced by a frame of solid drawn wire. The folded suspension lines are held in place by rubber loops attached to an inner bottom made of duck and supported by two strips of webbing. The sides and ends of the pack are so constructed as to completely inclose the assembly, yet allow instant release of the pilot parachute and canopy when the ripcord is pulled. The ripcord consists of a $\frac{3}{32}$-inch, stranded, flexible steel cable, which varies in length, depending upon the type of pack employed. On one end is attached a grip or handle by means of which the ripcord is pulled. The opposite end has two or three solid drawn-wire prongs which serve as the locking device for the pack assembly, and which must be withdrawn to release the canopy. The cable is inclosed in a flexible housing, one end of which is attached to the harness, so that the grip is readily accessible to the wearer. This housing provides protection for the ripcord and prevents any possibility of premature releasing of the parachute. The cable length for ripcords is measured from the grip to the end of the last wrap that holds the locking pins to the cable. The back type ripcord is 34 inches in length, while the seat type is 29¼ inches, and the chest type, 3¼ inches. This cable should be checked for length just before installing. The ripcord locking pins on the cable are 2¼ inches long. One inch of the pin is wrapped with fine wire and soldered to the cable, while the remaining 1¼ inches is

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exposed. The seat and chest packs have two pins, and the back type has three. To insure positive opening of the pack after the ripcord has been pulled, elastic cords, known as pack-opening elastics, are used. These cords are installed under tension in such a manner that when the ripcord is pulled, the sides and ends of the pack are forced away from the folded parachute. This permits the pilot parachute to be projected into the air, drawing the canopy from the pack and into position for opening. Directly under the side flaps of the pack are two similar pieces known as pilot-parachute flaps. When the canopy is folded and the sides and ends of the pack are in place, these superimposed flaps form a separate compartment in which the pilot parachute is placed. This arrangement assures the quick release of the pilot parachute and also serves to separate it from the canopy, lessening the danger of entanglement.

b. Types of pack assemblies.—The following table gives the types of packs used:

Type	Description	Parachute assembly	Canopy
			Feet
S	Service, small	S—seat, service (small)	24
S	Service, large	S—seat, service (large)	28
B	Service, back	B—back, service	24
BT	Training, back	T—training (double)	28
CT	Training, chest	T—training (double)	22

35. Harness.—*a. Construction.*—The harness consists of a fabrication of webbing that secures the parachute to the wearer. The service or (S) type of harness is in general use and will therefore be referred to in the following description. The principal elements are two main lift webs, which are composed of four pieces of three-ply linen webbing, sewed together. This provides two continuous lengths of double webbing to form the loops for the adjustable leg straps and the cradle or swing. When descending by the aid of a parachute, the wearer sits in the loop of this swing with the suspension lines of the canopy attached to the upper ends. The remaining webbing, comprising the harness, is for the purpose of preventing the wearer from slipping out by providing a means of adjusting and securing the assembly to the individual. Two additional webs extend from a point near the chest (under the breast guard protector) on the right and left main lift webs to the shoulder adapter to support the back straps. These webs cross the back of the

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wearer through the main lift web at a point near the tip, and continue horizontally to the rear at the small of the back, where they are interlocked and fitted so as to be adjustable for size. A breast strap is attached at a point near the center of the chest to keep the entire harness assembly in position and to prevent the main lift webs from slipping from the shoulders. The metal fittings attached to the harness include four double and one triple adapter as well as three male and three female fasteners. Noncorrosive cadmium plated chromium-nickel is used for the fittings. Two adapters are provided for adjusting the harness at the leg straps, while two more are placed at the shoulders for holding the harness. The triple adapter is used for adjusting both the cross strap and the horizontal straps around the small of the back. Male and female fasteners are used on the leg straps, hip straps, and breast guards of the harness, as shown in figure 91. The following table lists the types of harness in general use.

Harness types	Description
S	Used with both seat parachutes.
D	Used with double training parachutes.
B	Used with back parachutes.

b. Definitions.—The different parts of the harness may be defined as follows:

(1) *Main lift webs.*—These webs form the cradle and leg straps by means of two continuous lengths of double webbing, sewed together to form loops and extending to the risers at the shoulder adapters.

(2) *Risers.*—A continuation of the main lift webs, from the shoulder adapters, for attachment to the connector link.

(3) *Seat.*—This is often called the cradle, swing, or loop.

(4) *Leg straps.*—Two adjustable loops fitted with a male and female fastener at the seat and formed from the main lift webs.

(5) *Back diagonal cross straps.*—Two additional webs, which are sewed on the inside of the main lift webs at a point near the chest. These webs extend to the shoulder adapter and cross the back, diagonally, through openings provided on the sides of the harness at the hips. Attachment is made to the leg straps by male and female fasteners.

(6) *Back horizontal cross straps.*—A continuation of the diagonal cross straps. These webs pass through the opening provided in

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the main lift web at the hip, and extend around the small of the back where they are fastened with the triple adjusting adapter.

(7) *Hip straps.*—The loops which extend approximately 3 inches through the openings provided in the main lift webs, at the hip, for the horizontal and diagonal back straps. The hip straps terminate in male and female fittings for the purpose of fastening to the leg straps.

(8) *Breast straps.*—Additional members of the harness assembly, fitted with a male and female fastener, and fastened to the main lift webs at the breast. These straps are adjustable for up and down movement and are covered with duck protectors.

(9) *Harness fittings.*—Eleven metal fittings on the harness, consisting of matched male and female fasteners, double adapters, and a triple adapter.

36. Flyer's kit bag.—This bag is provided for conveniently carrying and transporting the parachute when not being worn. This bag is constructed of 12-ounce duck, reinforced with linen webbing, and has an interlocking fastener opening.

SECTION V

MAINTENANCE AND STORAGE OF PARACHUTES

	Paragraph
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Complete inspection	38
Repacking intervals	39
Folding and packing	40
Fitting and adjusting harness	41
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Testing	43
Cleaning	44
Storage and shipment	45
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37. Routine inspection.—All parachutes that are issued for service are checked for general condition and serviceability at least once every 10 days and a record of this inspection is maintained on W. D., A. C. Form No. 58 (Parachute Inspection and Drop-test Card). This is a responsibility of the operating activity or organization to which the parachutes are issued, and the inspection must be carried on by competent personnel. The checks, which are as complete and thorough as possible without breaking the seal and opening the pack assembly, are made as follows:

a. Note the date of last inspection and repacking, also that of the last drop-test, as entered on W. D., A. C. Form No. 58. If the

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specified period of these operations has elapsed, the parachute must be withdrawn from service for the accomplishment of the necessary work.

b. Carefully observe the external condition of the pack and harness assembly for any visible defects or deterioration, such as silk protruding at the corners, acid or oil stains likely to cause deterioration of the contents of the pack, etc. Note particularly the condition of all stitching. Check the harness webbing for damaged or weak spots, and for any rusted or defective harness fittings or snaps.

c. Check the condition, elasticity, and proper attachment of the pack-opening elastics.

d. Open the ripcord flap, and note whether or not the ripcord prongs are properly inserted in the cones, that the prongs are not corroded or bent, and that the ripcord seal is intact and properly applied.

e. Grasp the harness wedding at a point on the riser just above the ripcord grip pocket, and jerk mildly against the weight of the pack assembly to see that there is no possibility of the ripcord seal's being broken by excessive stretch or by improper location of the ripcord housing. Also check to see that the ripcord ring pocket holds the ring securely and permits the grip to protrude sufficiently to allow it to be instantly accessible.

f. If, as a result of the foregoing check any conditions are found that indicate need for repairs or a more thorough inspection irrespective of the date of last repacking, the parachute should be turned over to the parachute department for unpacking and complete inspection before further use.

38. Complete inspection.—In order to prolong the life and maintain the reliability of parachutes they must be carefully inspected at regular intervals, and repaired if necessary. To accomplish this inspection, the parachute is unpacked and stretched out on the folding table, where it is secured at points near the apex and just below the suspension line connector links, so that it is held taut. This may be accomplished either by the use of removable "pegs" placed in the folding table to which the various parachute fittings or lines can be attached as required, or by using weights. The harness is placed in the position that it would occupy if its wearer were lying on the table face downward, with his head toward the top of the parachute, as shown in figure 72. The two respective groups of suspension lines are separated as illustrated and the inspection carried on as follows:

a. The silk of the canopy is inspected for damaged and weak places by carefully looking over each panel and all seams. Mildew, rust,

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water or oil stains, battery acid, etc., will cause silk fabrics to deteriorate rapidly. If evidence of any of these conditions exists, the necessary repairs must be made, after which, if there is any doubt as to its serviceability, the parachute is drop-tested or reported for overhaul. The condition of the silk is not tested by attempting to tear it and any required patches are applied as shown in figure 67.

b. The rubber vent ring of the canopy is inspected and replaced if broken or if deterioration is noticeable. This may be done by removing the stitches of the hem for approximately 2 inches at the point where the vent ring splice is located and pulling out the old ring. A round molded-rubber strip, approximately 18 inches long, is then inserted and the ends spliced together so that the opening of the vent is four inches in diameter with no appreciable tension in the rubber. The splice is made by lapping the ends of the rubber approximately 1 inch, and wrapping with one turn of adhesive tape. The adhesive tape is then wrapped with number 16, 3-cord, linen thread. The function of the adhesive tape is to prevent the thread from cutting the rubber.

c. Each suspension line is visually inspected, and if evidence of deterioration is found the parachute is reported for overhaul. The point at which the suspension lines are attached to the connector links on the harness are particularly observed for evidence of rust. Under no circumstances are suspension lines repaired by means of knots or splices. In the event that any of the lines have been pulled loose from the zigzag lock stitching at the lower main lateral band, the parachute must be sent to the control depot.

d. The silk of the pilot parachute is likewise visually inspected for deterioration and damaged places. Small tears or holes may be repaired by patching. The framework is inspected for breaks and rusted joints, and replaced if not freely operative. The clip on the pilot parachute spring spacer assembly must be checked and resoldered if necssary. Working joints are lubricated with oil, lubricating, aircraft, instrument (specification number 2–27), to prevent rust and insure operation. After oiling, all excess lubricant must be removed with a clean rag.

e. The pack assembly is carefully inspected visually for any defects or deterioration due to wear in service. Pack assemblies, in which holes have been worn or which show other signs of deterioration, are replaced, except that where the condition of the pack warrants, minor repairs that can be made by stitching, or patching small holes, may be accomplished locally if the necessary facilities are available. Under no circumstances is stitching or patching accom-

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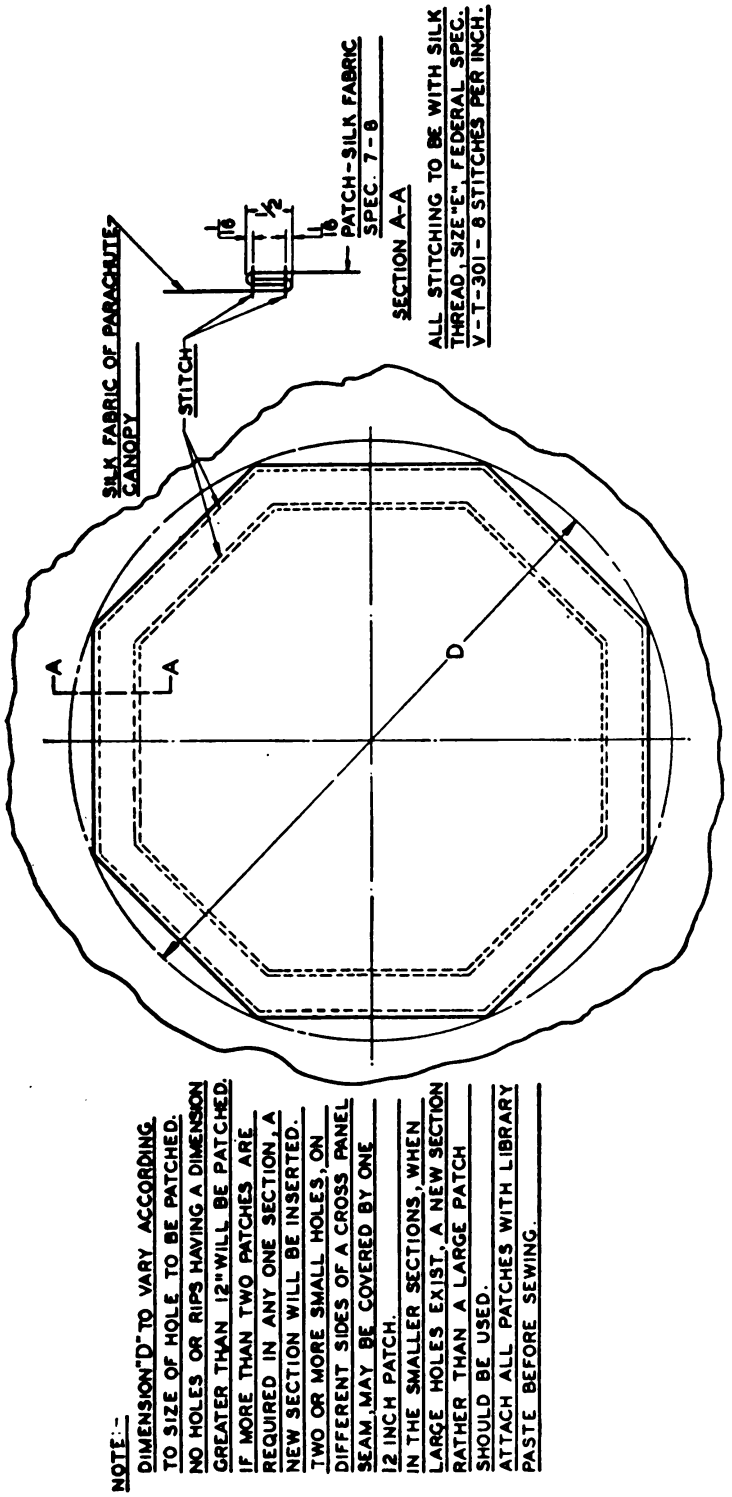

FIGURE 67.—Patching canopy.

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plished while the parachute is packed. Bent or broken frames that cannot be repaired locally are also replaced. Stains from water, oil, etc., which may cause deterioration to the silk are removed by washing the discolored area with warm water and Air Corps specification soap, after which care must be taken to remove all traces of soap by rinsing.

(1) Grommets are inspected and replaced if no longer serviceable.

(2) The cones in which the ripcord prongs are inserted are carefully examined, and all rough places and sharp corners removed. The surface of these cones should be perfectly smooth.

(3) Pack-opening elastics are replaced whenever any indication of deterioration or loss in elasticity is observed. When installing elastics, the hooks on each end are inserted in the eyelets on the pack with the open part toward the pack, and clinched after packing is completed. If the end of a hook is allowed to remain open, it may wear a hole through the pack and foul the pilot parachute.

(4) Worn or damaged seat and back pads must be replaced. Both pneumatic and sponge rubber pads are used for this purpose. In no case is a seat pad sewed to a packed parachute.

(5) Careful inspection of the ripcord housing is made for breakage and for improper attachment to the pack and harness. It should be so secured that, while the ripcord is in place, any stretching of the housing or pulling or jerking of the harness will have no tendency to withdraw the ripcord prongs from the cones. Failure to observe this requirement may result in premature opening when the parachute is being worn. The housing must also be carefully inspected for rust, flexibility, and length. A flexibility and breakage test is made by coiling the housing around a 2 inch metal bar or tube. If the housing cracks or takes a permanent set, it is unserviceable. There are two types of housings, the seat type which is 24¼ inches long and the back, 20 inches long. The measured length of a housing has a stretch allowance of ½ inch per foot. The chest type parachute requires no housing.

(6) The ripcord must be inspected to make sure that there are no rust spots and that the wrapping and soldering on the pins is smooth and unbroken. A check must also be made on the pins to see that they are not bent or defective in any way. All ripcord assemblies are inspected for soft locking pins. This inspection can be made by inserting ½ inch of the end of the ripcord pin between soft metal lined jaws of a vise or in a jig made by drilling a hole ½ inch deep in a soft metal block. A small spring scale is then hooked into the ripcord grip and a 7 pound pull ap-

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plied at right angles to the pin, being careful that the surface of the pin is not marred in any manner. All pins that take a permanent set are discarded as being too soft. Usually, pins that are too soft can be readily bent with the thumb and index finger of one hand. Ripcord assemblies must not under any circumstances be kept in service in a condition that might create a hazard if their use should be required in an emergency. This applies particularly to the condition of the cord at a point adjacent to the grip, below the solder, for at this point the flexing of the cable tends to break the strands. To guard against the possibility of failure, all ripcords are carefully inspected for broken cable strands, particularly adjacent to the grip, and for any other defects that might indicate failure of the assembly in normal use.

(7) The ripcord-ring pocket must hold the ring securely and permit the ripcord grip to protrude sufficiently to make it instantly accessible. Any pocket that allows the grip to fall out, or holds it so tight that withdrawal is difficult, must be repaired or replaced.

f. The harness is inspected for damaged or weak spots, especially those that may be produced from rust or battery acid. If the harness webbing shows evidence of wear, deterioration, etc., the harness assembly must be replaced. Inspection is made of the stitching and attachment of the harness to the pack. Harness fittings should be examined for breakage, rust, etc., with special attention being given to the condition of harness snaps and fasteners, the tongue and springs of which sometimes become weakened or bent. The rivets that hold the locking spring (tongue) to the female fastener must be properly headed through the fittings. If trouble is found in the fasteners or snaps they must be replaced. Male and female fasteners on parachute harness should be installed in matched pairs to insure perfect freedom of operation.

39. Repacking intervals.—Parachutes in service in insular possessions are unpacked, completely inspected, and repacked at least once each month; while those in domestic service are repacked at least once every 60 days. Regardless of the date when last inspected and repacked, any packed parachute found with evidence of damage to harness or pack must be unpacked and reinspected before being used. This also applies to any parachute having stains on the pack. Where the stains indicate that water, oil, acid, etc., have been spilled on the assembly, no time should be lost in making the inspection.

40. Folding and packing.—*a.* Folding the parachute is a simple operation, but one that must be thoroughly understood. Both care and accuracy cannot be over-emphasized. A shot bag or hook left

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in the pack, a knot in one of the suspension lines, or a suspension line dropped while being placed in the pockets are all mistakes easily made, but may result in parachute failure. Each step in the folding

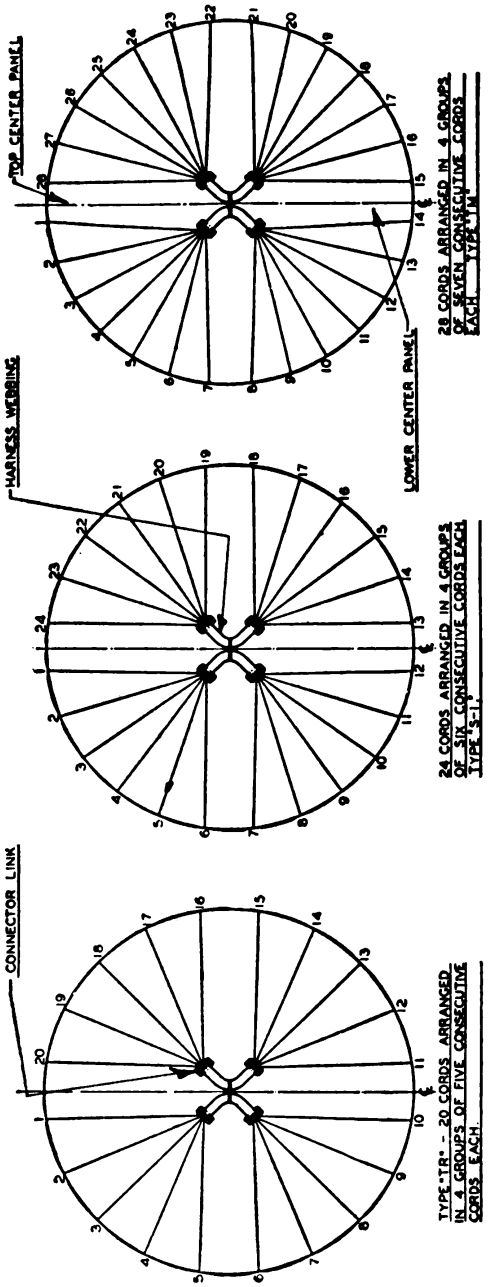

FIGURE 68.—Arrangement and numbering of suspension lines.

and packing of a parachute should be very carefully made, and the operator must direct his undivided attention to the work.

b. It is noted in figure 68 that there is a space through which a vertical centerline can be drawn without intersecting any of the lines

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representing the suspension lines or harness webbing. The point at which this line intersects the circumference locates the centers of two panels that are referred to as the upper and lower center panels. For convenience in instruction, the suspension lines are shown graphically in this figure and are numbered, beginning with the one at the left of the top center panel, anticlockwise, completely around the skirt of the canopy. The suspension lines nearest the centerline are the principal reference lines when parachutes are correctly laid out for folding (figs. 69, 70, and 71). The service or S-type parachutes are most generally used and will therefore be referred to in the following

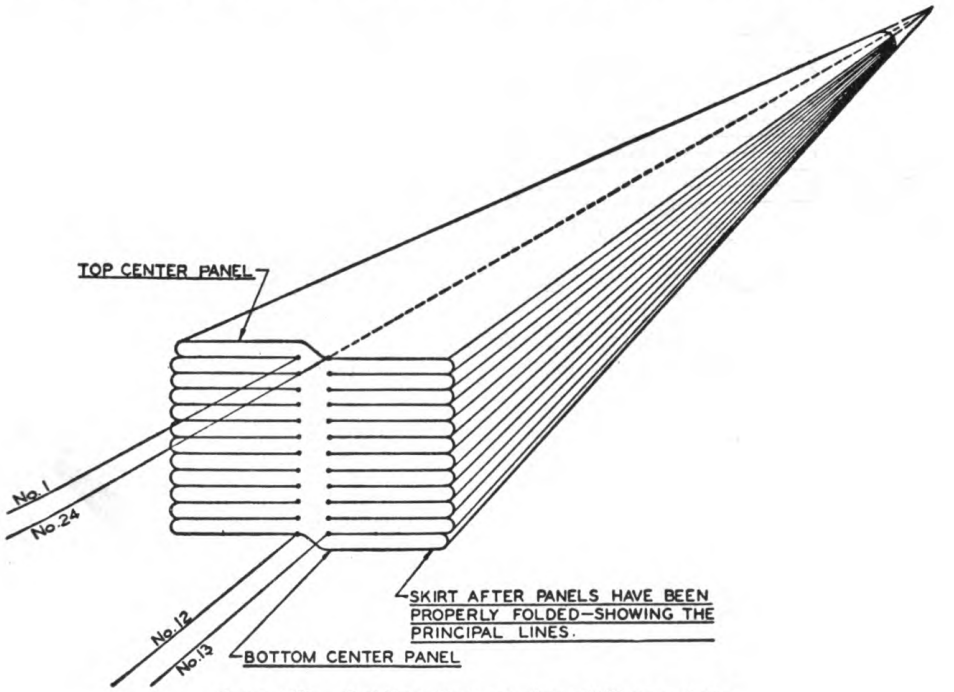

FIGURE 69.—Folding diagram, type "S" parachute.

procedure for folding and packing. The assumption is also made that a type S seat pack and harness are used although the instructions will apply to the other standard types of parachute assemblies by substituting their suspension line numbers in figure 69.

(1) After making the complete inspection, place the connector links of the harness lift webs over dowel pins in the surface of the folding table to hold the parachute taut. Grasp the suspension lines of the right group in one hand and those of the left group in the other and work toward the skirt of the parachute; thus separating the lines into two groups and at the same time dividing the panels as shown in figure 72. Thus arranged, the top center-panel (between lines Nos. 24 and 1) should be on the top, and the bottom center-panel (between

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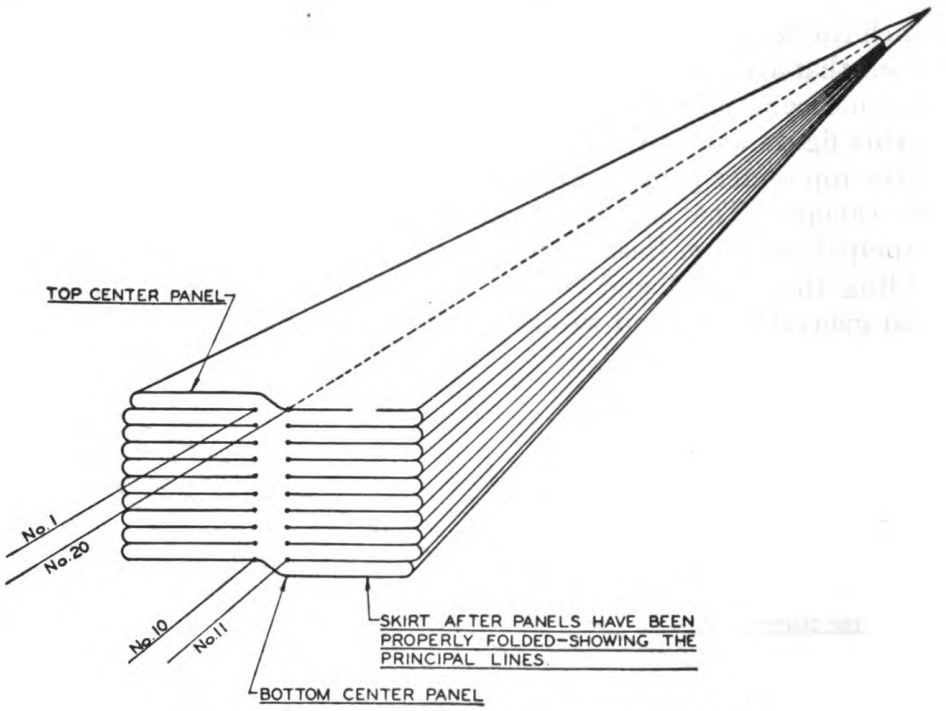

FIGURE 70.—Folding diagram, type "TR" parachute.

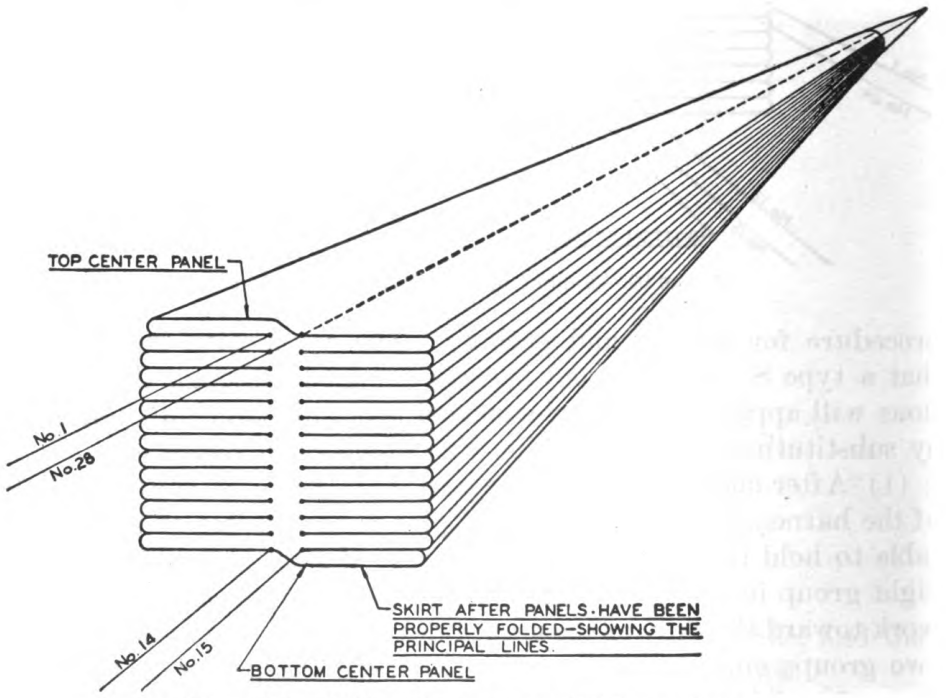

FIGURE 71.—Folding diagram, type "TM" parachute.

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lines Nos. 12 and 13) should be on the bottom, with lines Nos. 1 to 12, inclusive, in the left-hand group and Nos. 13 to 24, inclusive, in the

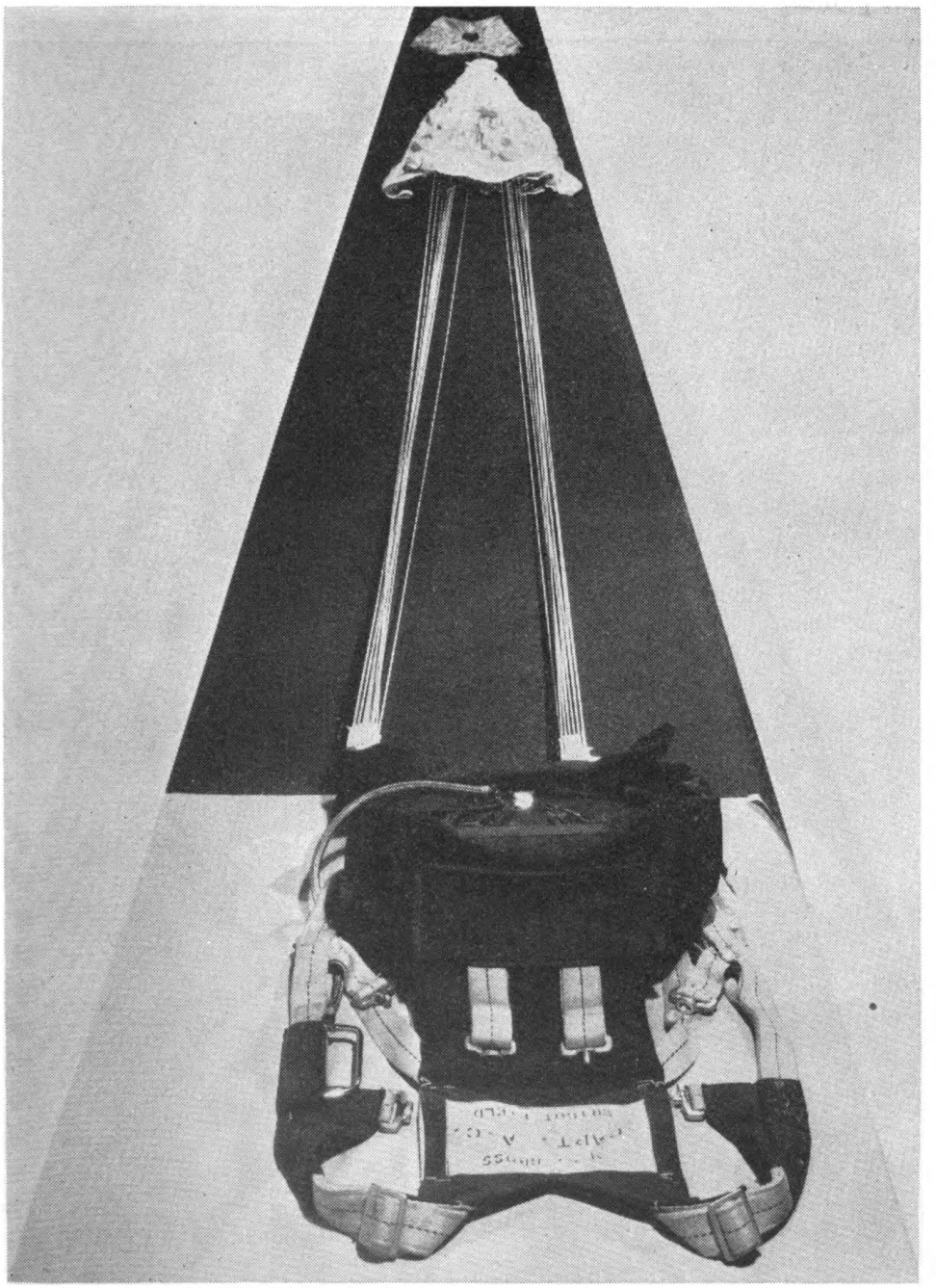

FIGURE 72.—Canopy, pack, and harness in position to start packing.

right-hand group. Next trace suspension lines Nos. 24 and 1 from the skirt of the canopy back to the harness connector links, ascertaining

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their correct location. Suspension lines Nos. 12 and 13 should be traced in like manner, placing the parachute in position for folding the panels.

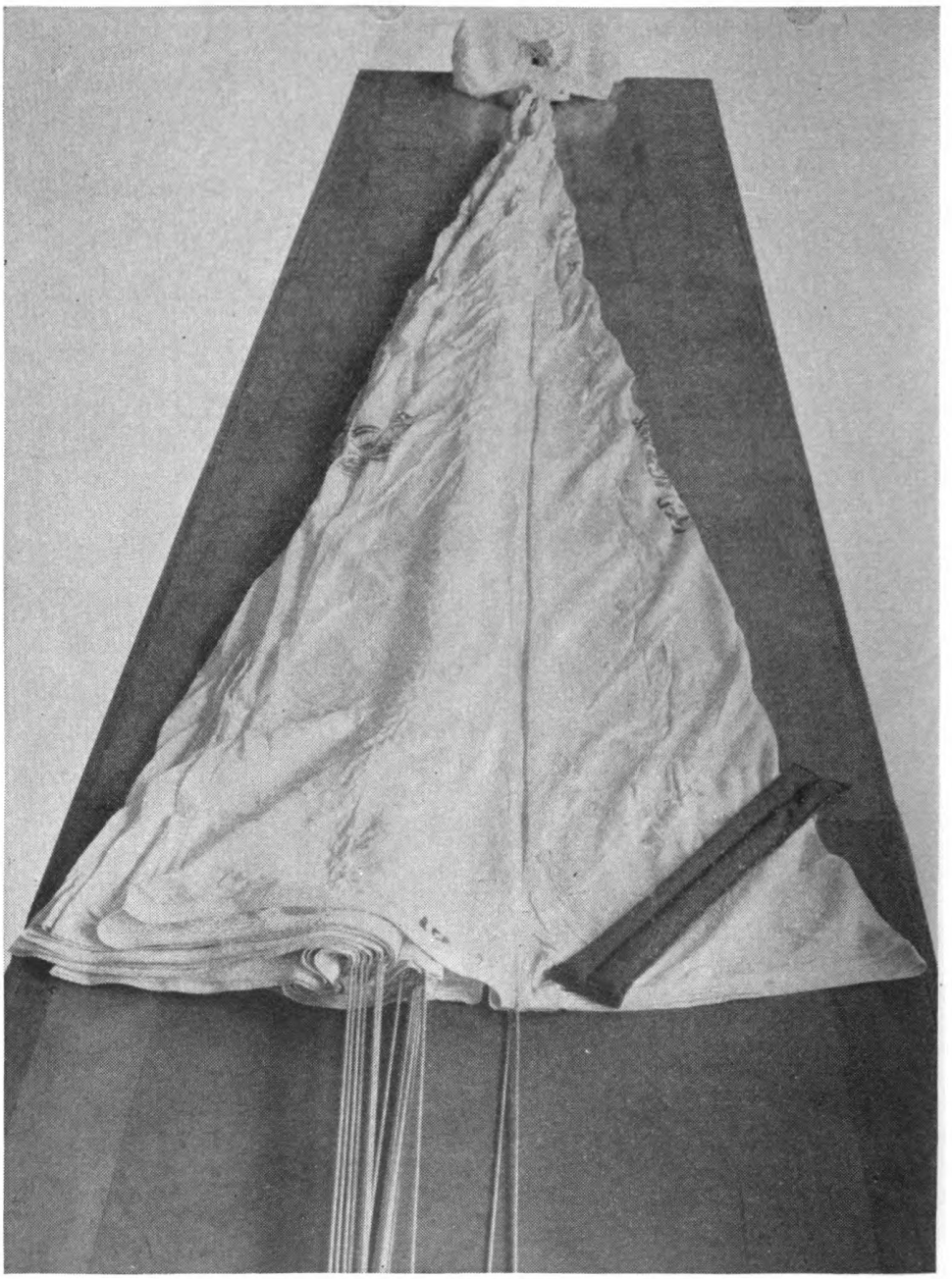

FIGURE 73.—Proper position of bottom panel, right-hand group.

(2) Holding the bottom panel in place on the folding table, place the remaining panels of the right group over to the left (fig. 73), and

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properly fold this panel (between lines Nos. 12 and 13) by stretching it out smoothly as illustrated. All suspension lines should be kept

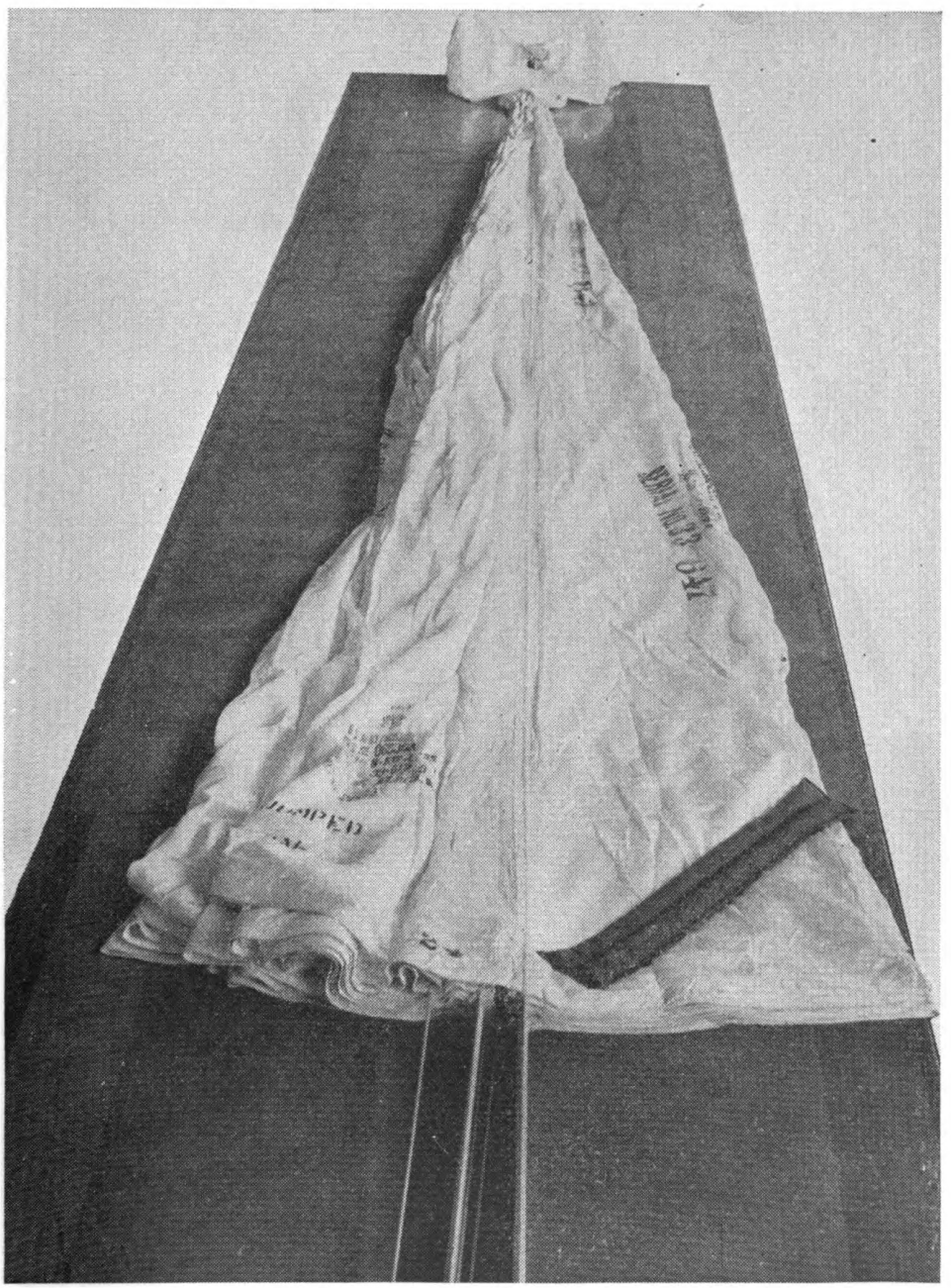

FIGURE 74.—All panels of right-hand group in position.

taut during the folding operation. Fold the remaining panels of the right-hand group in the same manner, placing the panels directly over

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each other in their correct order (fig. 69). The last panel of the right-hand group to be thus folded is the one between lines Nos. 23 and 24.

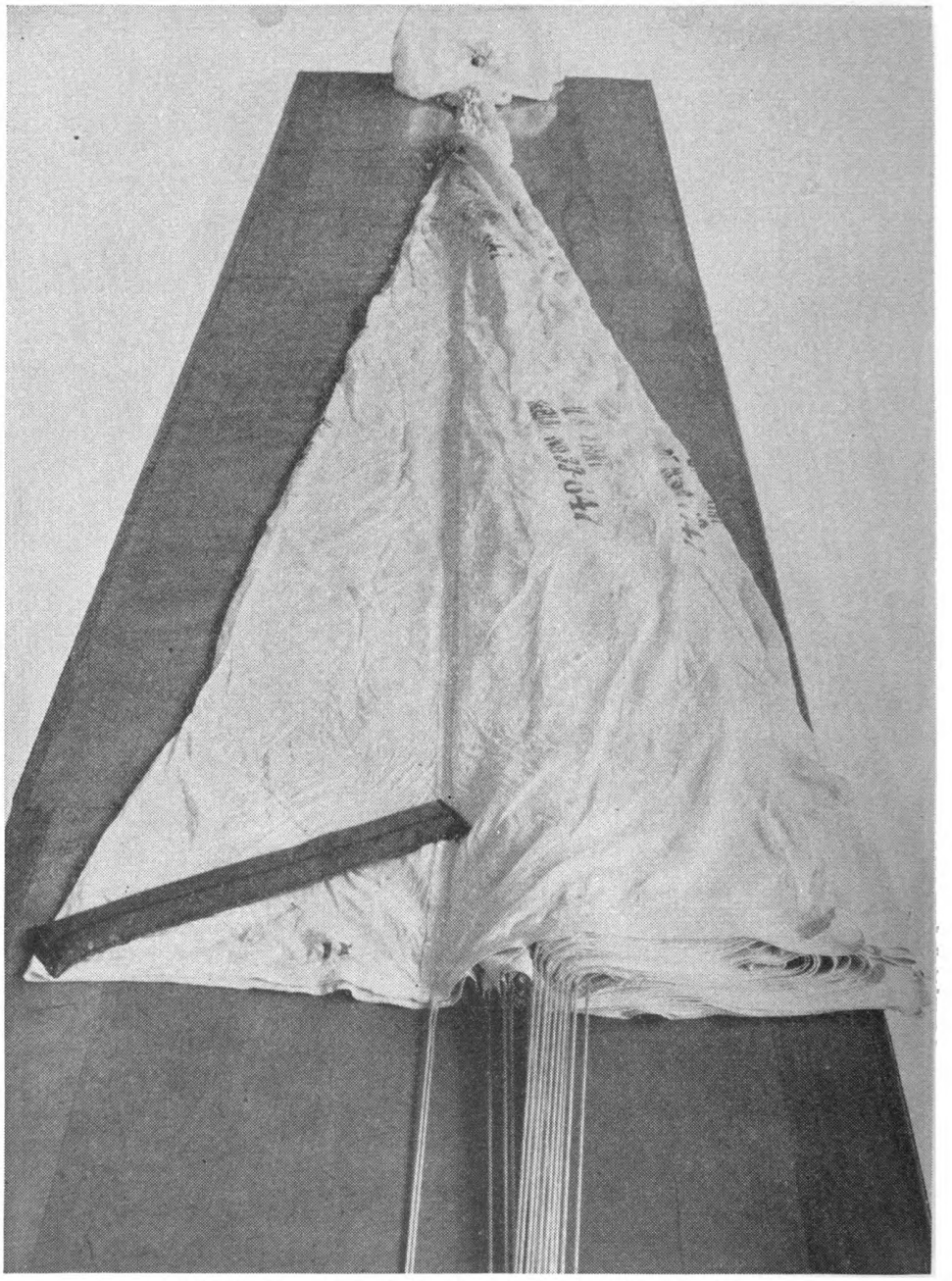

FIGURE 75.—Proper position of bottom panel, left-hand group.

After all panels of the right-hand group have been properly folded, place weights on them (fig. 74). Next throw the panels of the left-

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hand group over those of the right-hand group that have already been folded, so as to expose the bottom panel on the left-hand side, which is

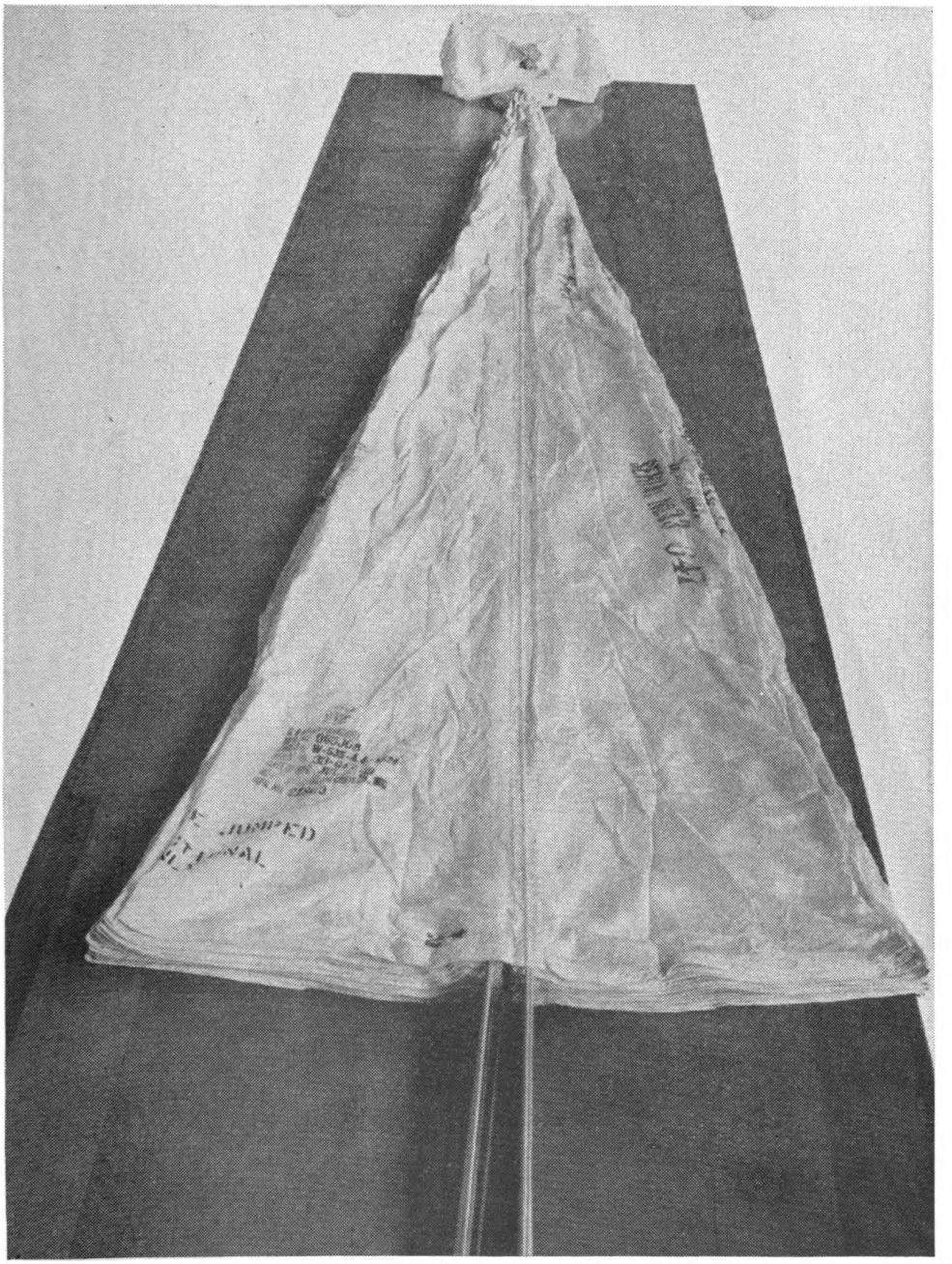

FIGURE 76.—All panels in proper position for folding.

the one between lines Nos. 11 and 12. Fold this panel to the left-hand side (fig. 75), and fold the remaining panels of the left-hand

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group in their proper order over this one. The last panel of the left-hand group to be folded is the one between lines Nos. 24 and 1, or

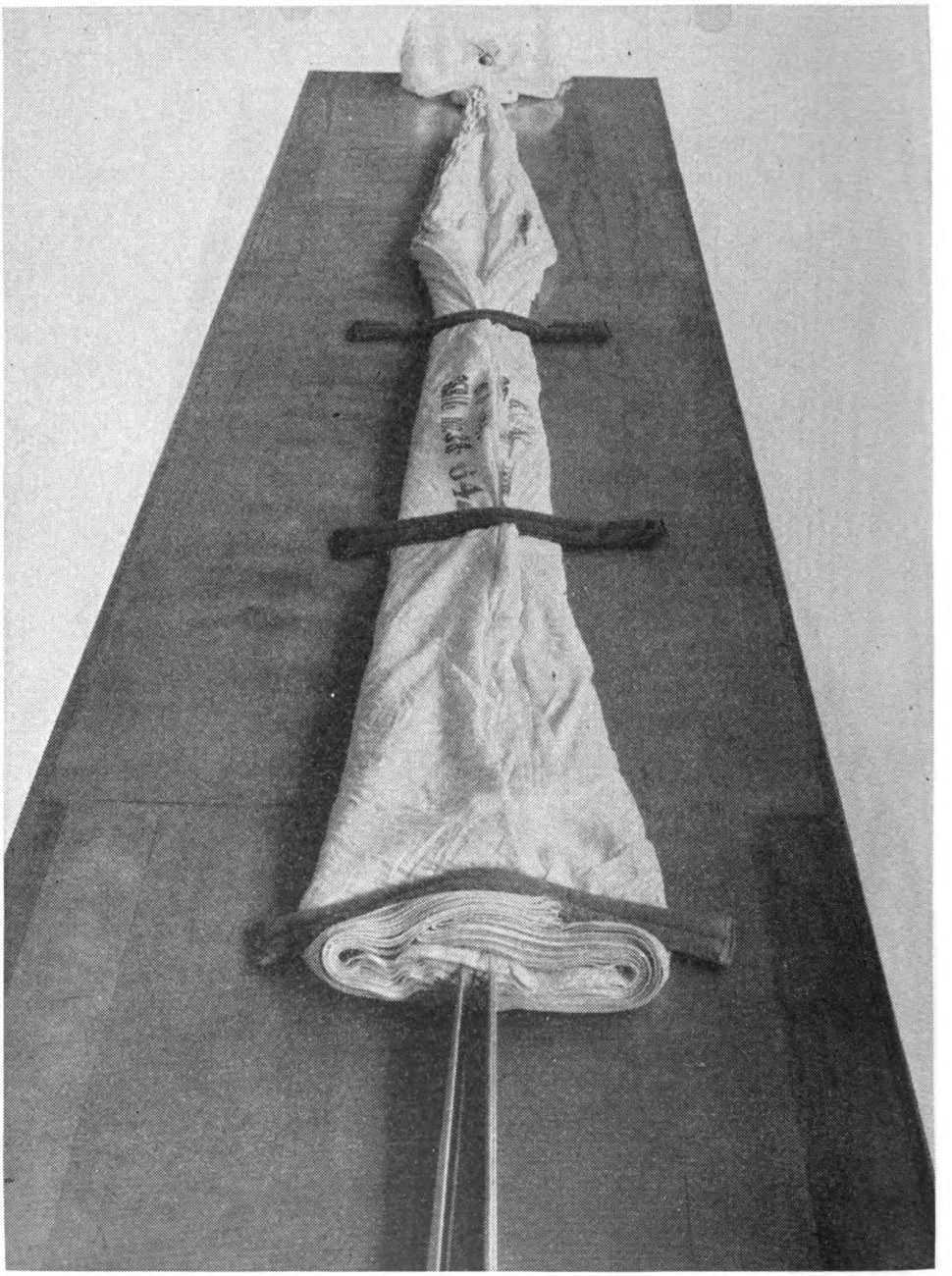

FIGURE 77.—Panels folded over to proper pack width.

the top center-panel. All panels are then in their proper position (fig. 69). (Figs. 70 and 71 show this position for the other standard

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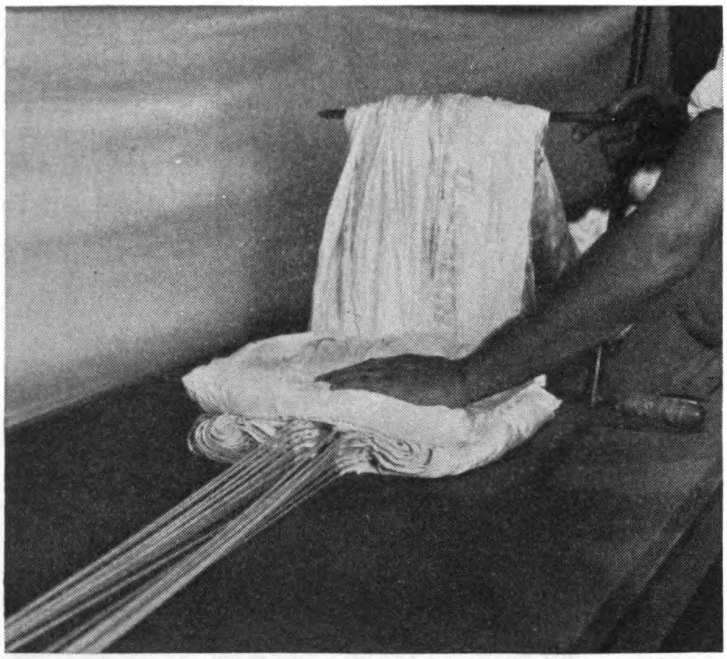

FIGURE 78.—Folding canopy.

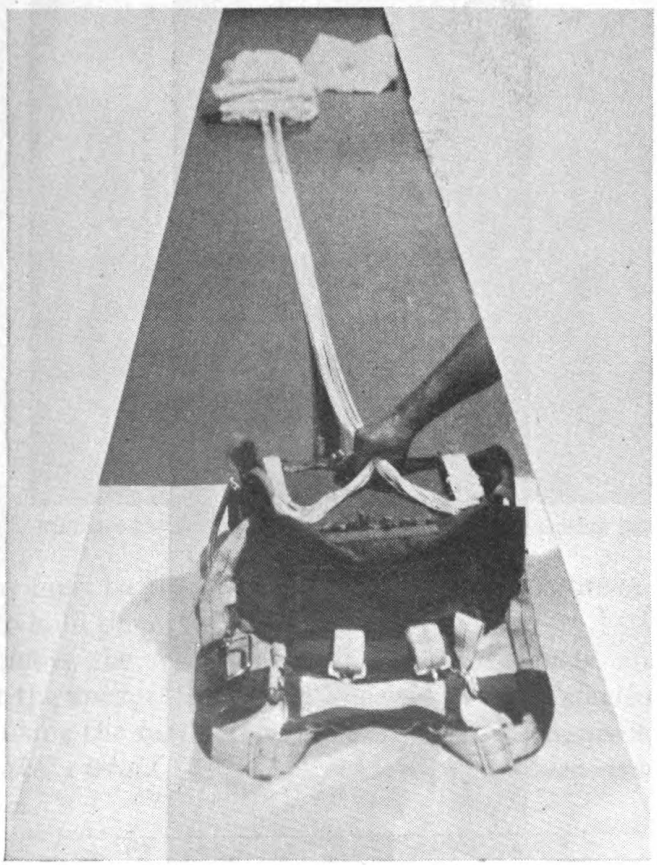

FIGURE 79.—Position of main lift webs.

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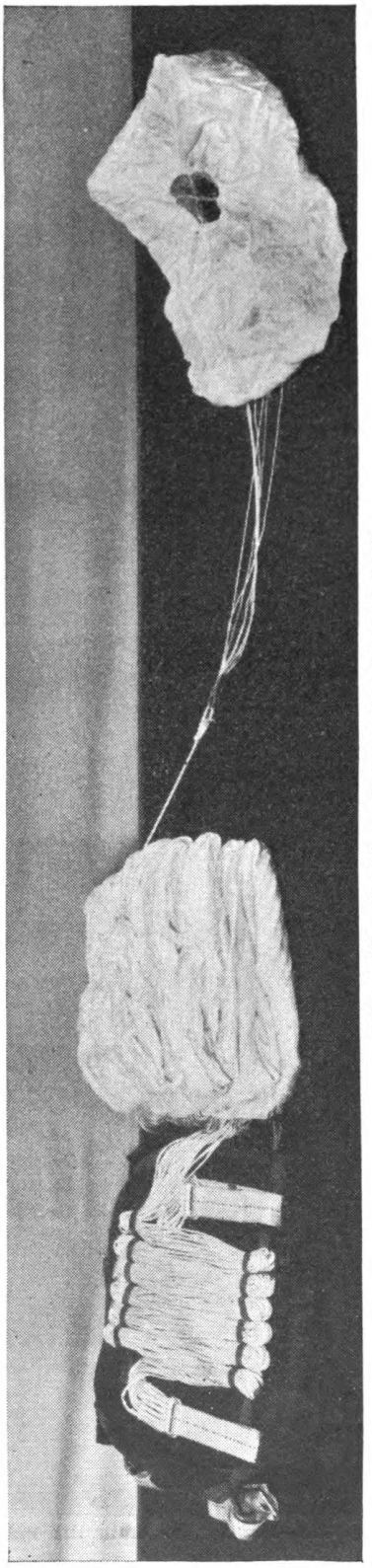

FIGURE 80.—Position of suspension lines in pack.

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types of canopies.) By referring to the folded canopy skirts, shown in the figures, it may be seen that only the top center-panel on the top and the bottom center-panel on the bottom, cross the center line. Figure 76 shows all panels in proper position for folding.

(3) Double over each group of panels (fig. 77), so that the over-all width of the folded panels is equal to the equivalent width into which

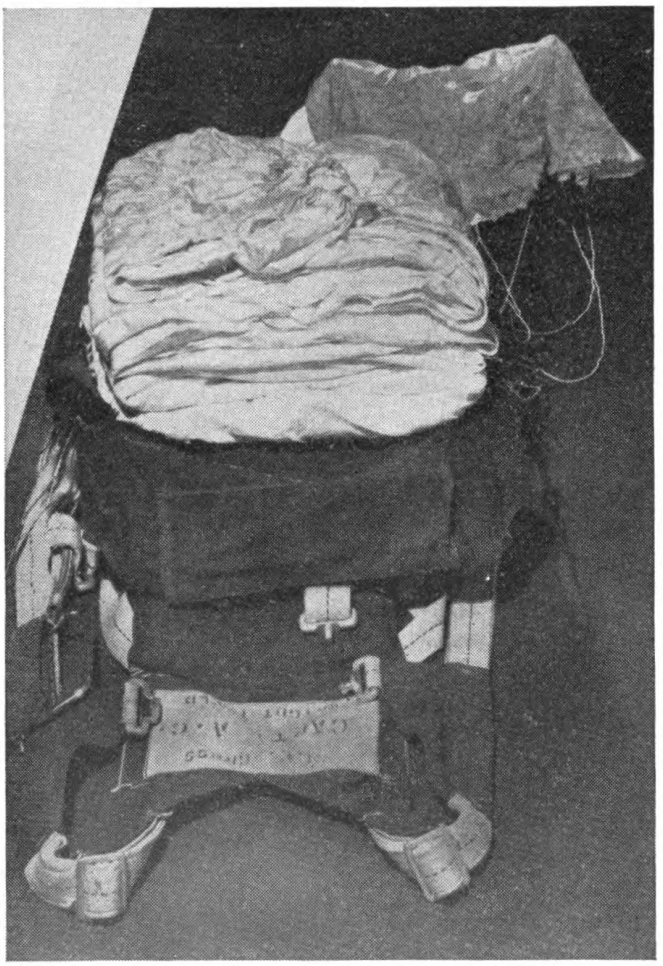

FIGURE 81.—Folded canopy in position prior to closing pack.

the canopy must be placed in the pack. Place weights over these folds in order to hold them in place.

(4) Remove the weights from the folded panels, and release the canopy at the apex, then fold it in accordion folds starting at the skirt (fig. 78), using the folding tool illustrated at (5) figure 9, for this purpose. *Make certain that all weights have been removed before continuing.*

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(5) Place the main lift webs so that they extend across the pack and grasp the suspension lines in one hand (fig. 79). With the other

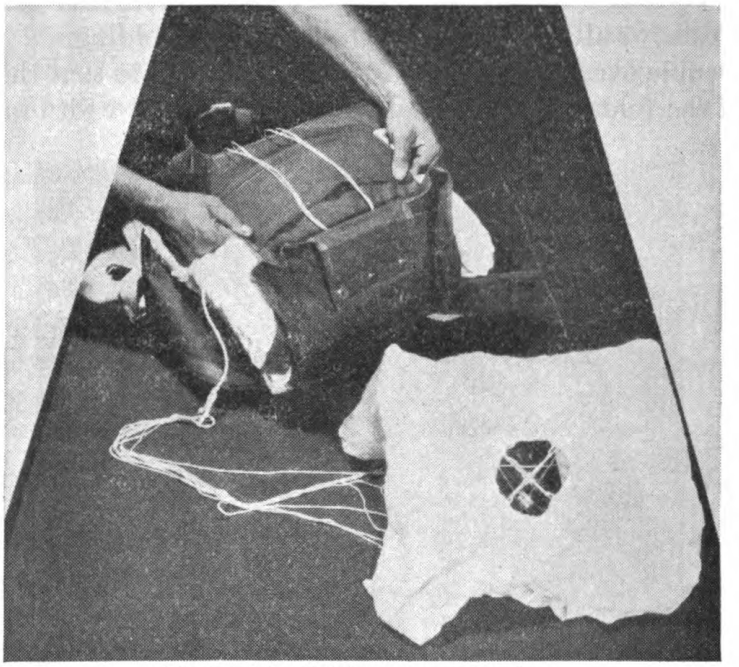

FIGURE 82.—Folding over inner flaps.

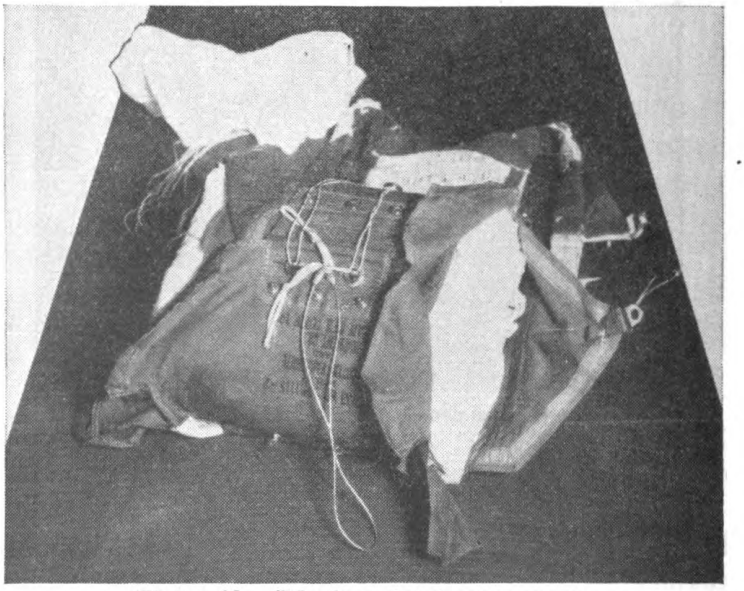

FIGURE 83.—Side flaps closed over canopy.

hand lift the pack and harness assembly to a position adjacent to the skirt end of the folded panels, then draw the suspension lines through the rubber loops provided for them (fig. 80). Leave ap-

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proximately one foot of the suspension lines free between the canopy and pack and lay them loosely across the lines already located. Make certain that there are no twists or tangles in the suspension lines, as either may cause failure in the opening of the canopy.

(6) Place the folded canopy onto the pack, over the folded suspension lines, with the apex uppermost (fig. 81). Pass 100-pound silk cords through each of the ripcord pin holes of the pack cones and fold over the pilot-parachute flaps (fig. 82). Next, pass the free ends of the 100-pound cords through the grommets in the outer pack

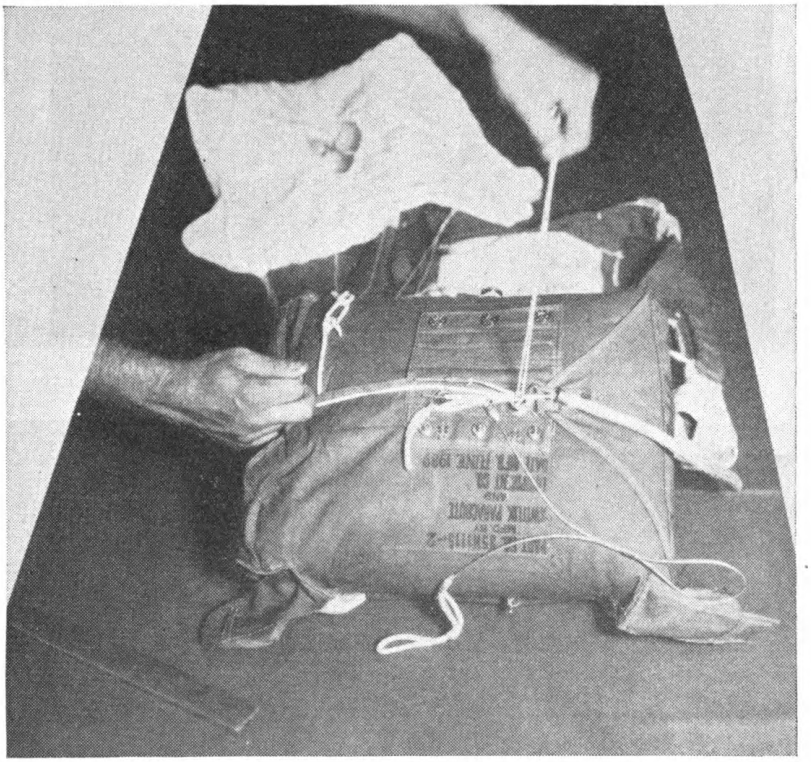

FIGURE 84.—End flap with ripcord housing in position.

flap and with the aid of these cords pull the sides of the pack into position bringing the pack cones into the grommets (fig. 83). Pull the end flaps with the ripcord housing attached into place (fig. 84), bringing the grommet over the cone. Temporarily lock the cones with a spare ripcord, and make certain that the pilot-parachute bridle lines enter the pack on the opposite end from that to which the ripcord housing is attached. (The type TR unit has no pilot parachute.)

(7) Arrange the pilot parachute and suspension lines (fig. 85), then fold it by holding the eye loop in one hand, grasping the sus-

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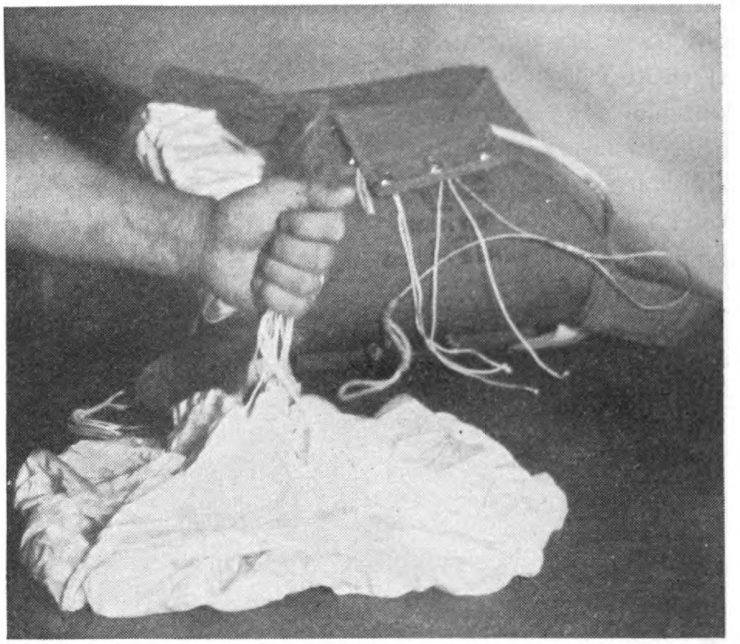

FIGURE 85.—Arrangement of pilot chute and lines.

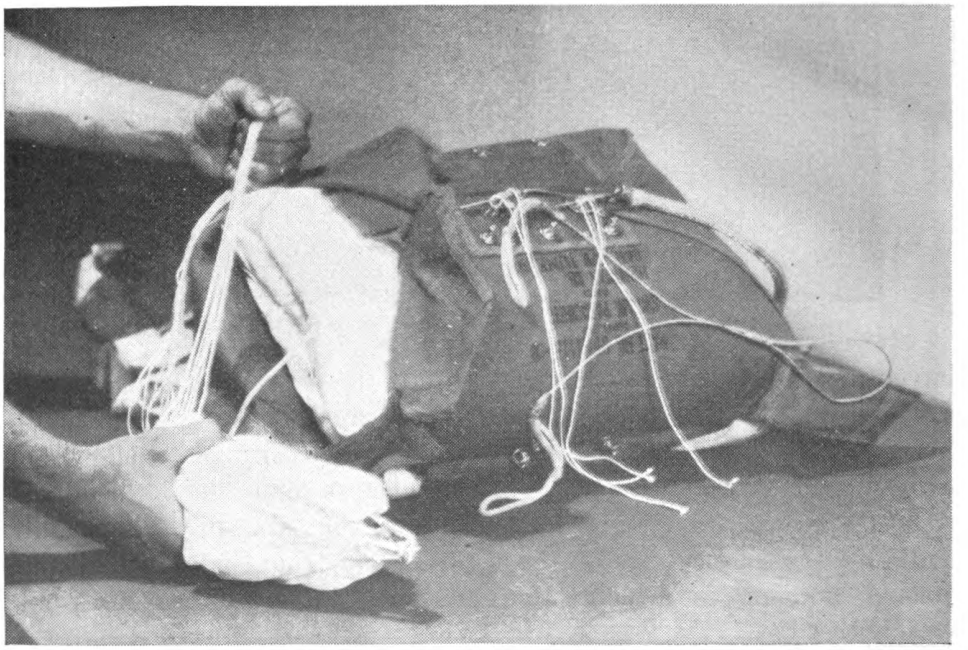

FIGURE 86.—Folding pilot chute.

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pension lines with the other, and thus pulling the frame together (fig. 86). The folded pilot parachute is then inserted in place between the overlap of the parachute flaps (fig. 87). Fold the suspen-

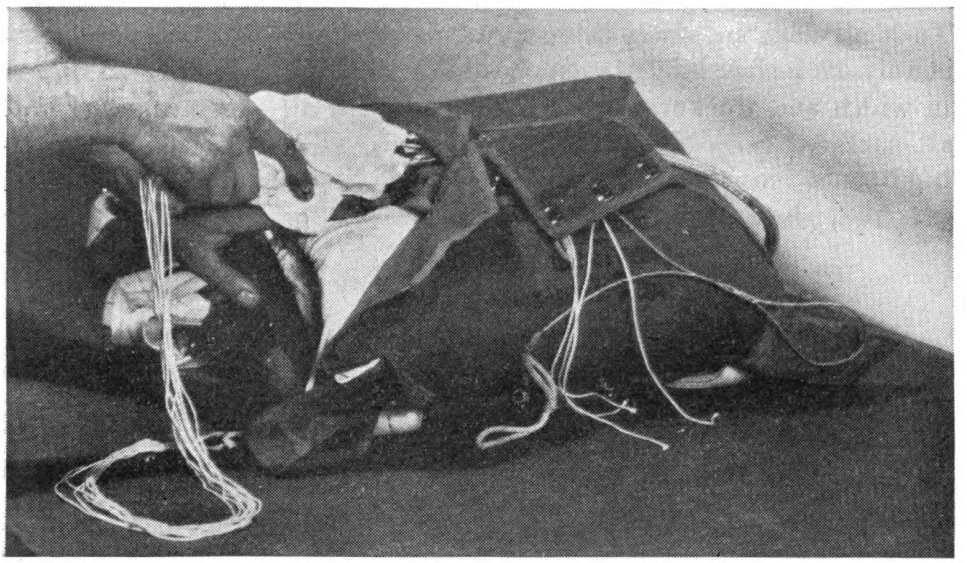

FIGURE 87.—Inserting pilot chute.

FIGURE 88.—Pack in readiness to close remaining end flap.

sion lines in accordion folds and tuck them under the ends between the overlap of the superimposed flaps (fig. 87). Under no circumstances may any part of the pilot parachute skirt or its suspension lines be wrapped around the outside of the folded frame when packing the assembly.

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(8) Carefully tuck the protruding part of the canopy into place (fig. 88), and pull the remaining end of the pack up into position (this is also done by the use of a cord through the cone and grommet), again locking the cones in place by means of a spare ripcord. Tuck all flaps in place, using a varnished hardwood stick approximately 12 inches long, 1½ inches wide and 5/16 inch thick, tapered in width and thickness at one end, and with all edges rounded and all surfaces carefully smoothed. Remove all cords used in drawing cones in place. Remove the spare ripcord and install one that has been thoroughly inspected for condition. After

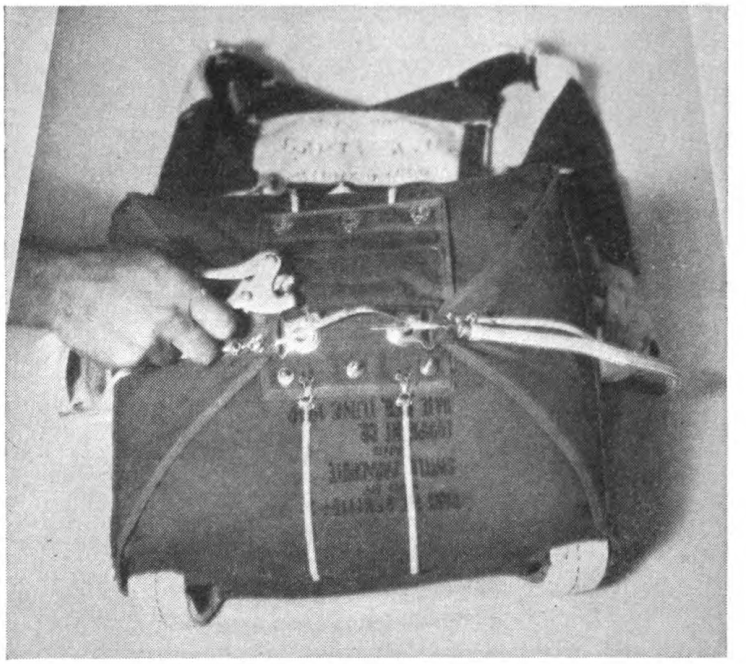

FIGURE 89.—Method of sealing ripcord.

inserting the ripcord pins in the cones, seal the end pin by means of one wrap of No. 12, 4-cord, cotton thread (Spec. No. VT-276). Securely knot the free ends of the sealing cord and compress a lead seal over the knot and cord (fig. 89). Both ripcord prongs on the type TR parachute are sealed. Seals and presses for this purpose are obtained from the control depot, but are only issued locally to authorized parachute maintenance personnel. After the pack is neatly straightened and the flaps are well tucked in place, hook the pack-opening elastics. All hooks are inserted from the outside and clinched after they are in place. Insert the ripcord grip in the pocket provided, making a half twist in the direction of the twist of the cable.

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(9) When the foregoing operations have been completed, W. D., A. C. Form No. 58 is accomplished and inserted in the pocket as shown in figure 90.

41. Fitting and adjusting harness.—*a.* All parachute harnesses must be adjusted to the wearer to provide a snug, comfortable fit and to prevent loose folds of webbing from catching on projections

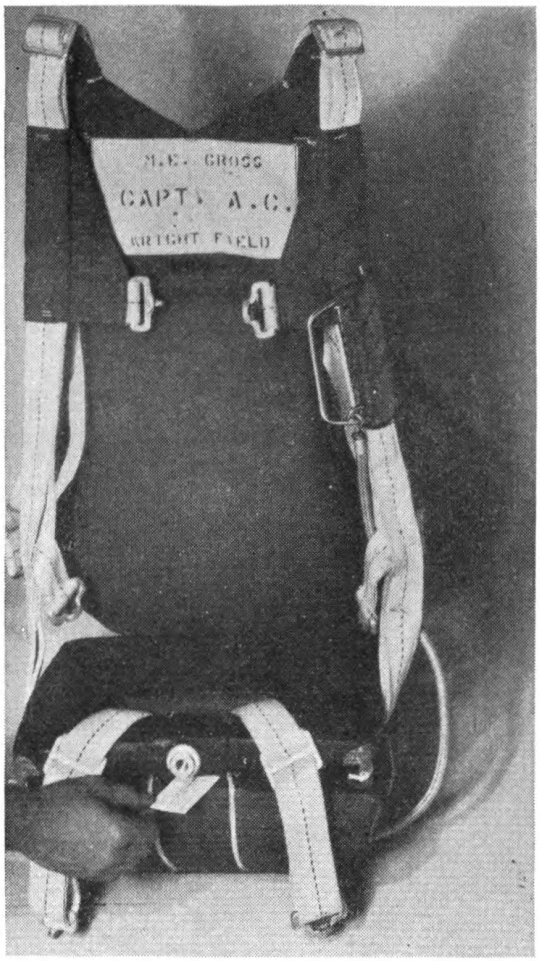

FIGURE 90.—View of back pad, seat cushion, name pad, and pocket for inspection and drop test card.

when getting in and out of the airplane. Proper adjustment also prevents the lift webs from slipping off the shoulders. Fitting of the harness to the wearer is accomplished after the parachute has been properly packed.

b. The first operation in adjusting the S, D, and B type harnesses is to place the double shoulder adapter at the top of the shoulders as shown in figure 91. A triple adjusting adapter is provided on the

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horizontal back strap and a double adapter on each of the two leg straps. After the back straps have been adjusted to fit the wearer properly, the back triple adapter-fitting should be arranged so as to be on the right side for comfort. Any surplus length of the back-strap webbing is folded back and forth, single-thickness, across the back pad and stitched so that no uncomfortable bundle

FIGURE 91.—Front view of seat type harness, type S.

is formed. The breast straps should be located approximately 12 inches below the chin, where they are securely tacked to the harness lift webs.

c. After all adjustments have been made to fit the wearer, the webbing is tacked with two turns of No. 16, 3-cord linen thread at the locations indicated by the arrows in figures 91, 92, 93, and

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94. When using this thread for hand sewing it is doubled and waxed with pure beeswax. The sponge rubber back pad on the seat type parachute is fitted so that the thick portion is placed at

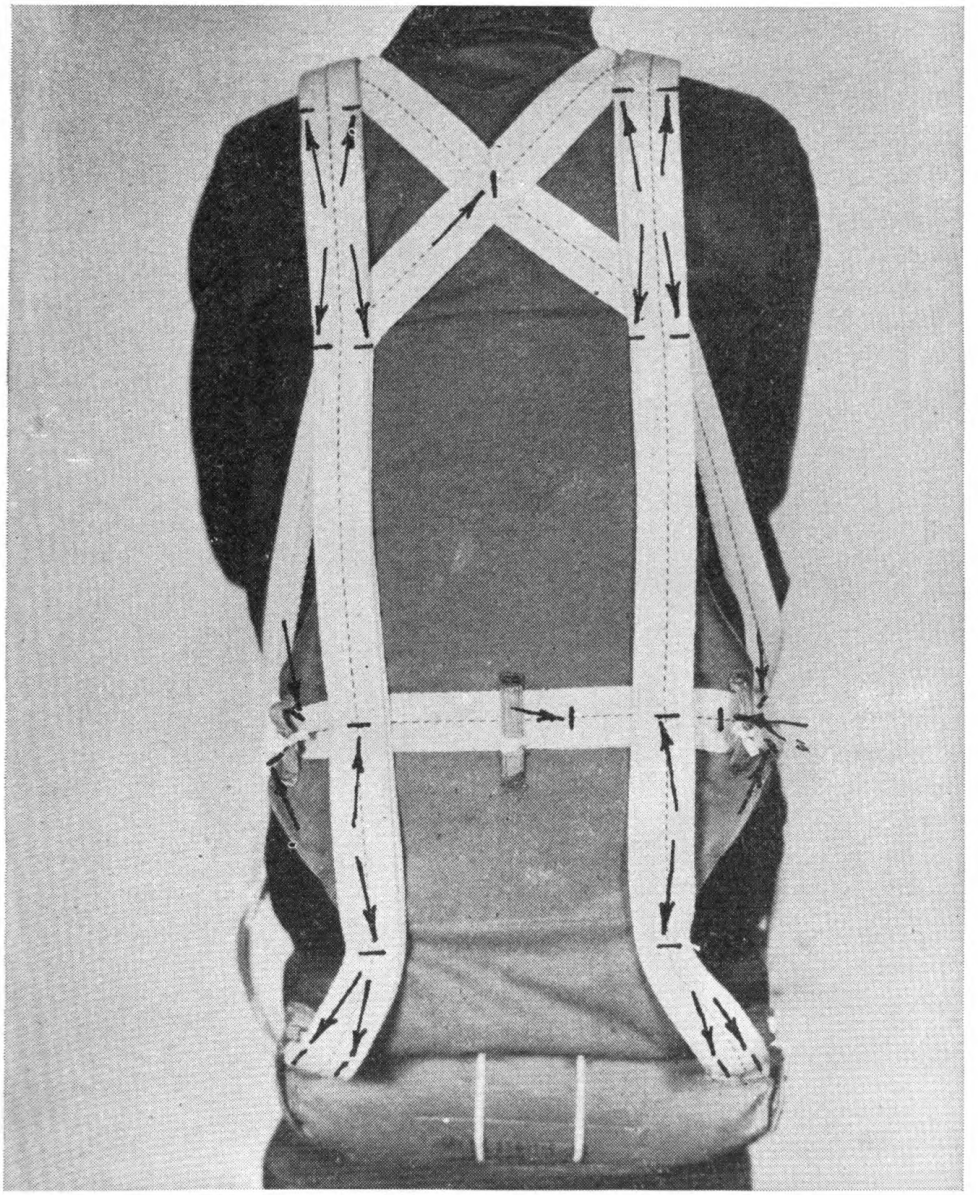

FIGURE 92.—Back view of seat type harness.

the small of the wearer's back. It is attached to the harness by stitching to the cross back strap at the shoulder adapters, so that the lift webs are held close to the neck. It is also stitched to the horizontal back strap in the region of the small of the back. The

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eyelets on the sides of the pneumatic type back pads are located parallel to the opening of the main lift web by raising and making a plait in the duck of the pad.

FIGURE 93.—Appearance of properly fitted harness when wearer stands erect.

d. Figure 93 shows the appearance of a properly fitted seat type parachute with the wearer standing erect while figure 94 shows the arrangement of the chest pack in a type T, training parachute assembly. Figure 95 shows the appearance of the back type para-

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chute either when used singly or in combination with the chest type to form the training assembly.

e. Adjustment of the leg straps is accomplished by moving the leg strap double adapter back toward the point of attachment on the

FIGURE 94.—Position of chest pack of training combination.

lift webs, until a snug fit is obtained. If slippage is encountered, the webbing adjacent to the adapter on the left leg of the wearer is tacked with two turns of No. 16, 3-cord linen thread, as shown in

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figure 91. Where sufficient adjustment of the leg straps is not obtainable by this method, further tightening is accomplished by pulling out the loop of the webbing to the rear of the adapter, and tacking it with two turns of No. 16, 3-cord linen thread at the points indicated on the right leg of the wearer (fig. 91).

42. Repair and overhaul.—*a. Repair.*—The term "repair" applies to such operations as replacing pack assemblies, pack-opening rubbers, harness assemblies, pilot-parachute assemblies, vent rubbers, minor repairs to packs, repairs in stitching (except zigzag stitching in canopy), replacement of harness snaps and fittings, and repair of torn places in the canopy which do not exceed 12 inches in diameter. Such repairs may be accomplished by any activity having qualified personnel and the necessary equipment. Under no circumstances is parachute silk salvaged from parachutes retired from service due to age or deterioration used in the repair of active parachute canopies.

b. Overhaul.—The term "overhaul" includes, in addition to the work outlined in *a* above, all major repair operations necessary to place the parachute assembly in first-class condition. Overhaul is accomplished by depots only.

(1) Parachutes are forwarded to the control depot for complete inspection and overhaul only as warranted by their condition, the extent of repairs required, or the lack of local repair facilities. Normally, they are forwarded to the depot when their condition, as disclosed by local inspections, indicates the need for repairs beyond the scope of *a* above, when they cannot be repaired locally, or whenever doubt exists as to their further serviceability. The date of each depot inspection and overhaul, preceded by the letter "O", is stenciled on the skirt of the canopy. Figures and letters ¾ inch high are used for this purpose. For example: "O–1–15–39" indicates that overhaul was accomplished January 15, 1939.

(2) Whenever a replacement pack or harness assembly is installed, or when a new parachute assembly on which the required pack and harness dates have not been stamped is issued, the date, preceded by the letter "R", is stenciled on the pack and harness, in the following locations, using letters and figures ½ inch high:

Harness—On the right-hand front harness web, as its location on the chest.

Pack—On the ripcord protector-flap.

For example: "R–2–15–39" will indicate replacement made February 15, 1939. Normally, unless visibly defective, harness assemblies need only be replaced at the expiration of three years of service,

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FIGURE 95.—Position of pack on back type parachute.

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except that in the Panama Canal and Philippine Departments, the service life of harnesses is limited to a maximum of two years.

(3) Certain limitations are placed on the cost of making major parachute repairs. For information in this connection refer to Air Corps Technical Orders.

(4) All parachutes bear, in addition to the markings previously described, the name of the station and individual to whom the parachute is assigned. This information is stenciled in the space provided for this purpose on the back pad as shown in figure 90.

43. Testing.—*a.* New parachutes are drop-tested by the contractor prior to delivery and, in the case of overhauls, each parachute is drop-tested by the depot upon completion of the repairs. Subsequent drop tests of parachutes are accomplished at least once every 24 months until the parachute reaches four years of age. Thereafter they are drop-tested at least once each 12 months.

b. Parachutes may be drop-tested with any airplane equipped with external or internal bomb-racks capable of supporting at least 200 pounds. When using external wing-racks, the total weight of the dummy and parachute must not exceed 200 pounds. When dropped, the parachute is observed for promptness of opening and for signs of strain or defects to material. Opening should occur within 3½ seconds and all drop-tests should be accomplished with a standard dummy, at a speed of 100 miles per hour. The complete parachute assembly is fastened to the test dummy by means of the regular harness, and the dummy is secured to the bomb rack, head forward, in the same manner as a bomb. The ripcord is secured to the bomb rack by a static parachute test line and the parachute is released from the rack by means of the bomb-release mechanism.

c. After drop-testing, the parachute is given a thorough inspection and repaired where necessary.

d. The date of the parachute drop-test is entered on W. D., A. C. Form No. 58 (Parachute Inspection and Drop-Test Card) and W. D., A. C. Form No. 46 (Parachute Record Card).

e. Activities having no facilities for drop-testing parachute must make arrangements with the control depot for the accomplishment of this work.

44. Cleaning.—*a.* Parachutes that have come in contact with salt water are immediately unpacked, and the canopy and suspension lines rinsed in fresh running water for 10 minutes (soft water being preferable when available), then suspended and allowed to dry for at least 48 hours, or as much longer as is necessary to insure thorough drying. No attempt should be made to wring out the canopy or

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suspension lines. The harness and pack must be replaced, and disposition made of the removed parts. Such parachutes are carefully inspected before repacking and at each subsequent repacking after being placed in service. If any evidence of abnormal deterioration is apparent, the parachute must be immediately shipped to the control depot for disposition. Parachutes that have been submerged in salt water more than 24 hours should be disposed of.

b. In the event that a canopy becomes badly stained with oil, grease, or other foreign substance, the parachute should be returned to the control depot for cleaning. Slight discoloration of the canopy from oil or grease may be removed by washing the discolored area with lukewarm water and Air Corps Specification soap, followed by a thorough rinsing. Mud or other foreign matter should be removed from the canopy by air drying and brushing. In general, the cleaning of parachutes should be kept at a minimum, although, when it is considered necessary, it may be accomplished by either dry cleaning or steam cleaning in accordance with specification No. 20021.

45. Storage and shipment.—*a.* Parachutes should be stored in a dry place, protected from the sun's rays, and frequently inspected for evidence of any deterioration. Except those required for current issue, all parachutes must be stored unpacked, preferably by suspending the canopy from the apex. The silk should not be compressed, nor should the pack-opening rubbers be left under tension. Parachutes should never be left packed or placed in storage when in a damp condition. Assemblies in this condition must be thoroughly aired and dried at once.

b. Parachutes are shipped unpacked, with their canopies loosely folded. Within the continental limits of the United States, shipments are made in the flyer's kit bags with the bags inclosed in suitable pasteboard boxes. In the case of shipments to insular possessions, the parachutes are individually wrapped in wrapping paper and shipped in wooden shipping cases which have been lined with waterproof paper. Upon receipt at insular possessions, the parachutes must be promptly inspected. Any instances of parachutes having become contaminated with water must be immediately reported by radio to the material division.

46. Prevention of mildew.—Fabrics are particularly susceptible to damage by mildew in regions having a warm, humid climate. Activities in the insular possessions, affected by such climatic conditions, and elsewhere if the presence of mildew is found or suspected, should adhere to the following:

a. All parachutes should be kept as clean as possible, as the propagation of fungi or mold is dependent to some degree on a nutrient,

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which may be oil, grease, starch, glue, sizing, etc., in the fabric. Any necessary cleaning should be accomplished as previously described.

b. The parachute must be thoroughly dried in a well ventilated room at normal temperature before packing. The room should be of sufficient height to permit the canopies to be suspended clear of the floor and equipped with fans to increase the flow of air through the drying room.

c. All packed parachutes, not actually being used, should be kept in tight lockers or bins, at the bottom of which are placed suitable containers for dispensing naphthalene fumes (3 pounds of naphthalene flakes, specification No. R-N-91, to each 10 cubic feet of locker space). In most cases, the fumes from the naphthalene flakes penetrate the packed parachute sufficiently to prevent the formation and growth of fungi, although under extreme climatic conditions approximately ⅛ pound of naphthalene flakes may be sprinkled over the folded panels of the canopy, prior to the final folding operation, when the parachute is being repacked.

SECTION VI

INSTRUCTIONS FOR USING PARACHUTES

Paragraph
General 47

47. General.—*a.* The use of parachutes by pilots and passengers on all flights in Army aircraft is made mandatory in accordance with AR 95-15.

b. Detailed instructions for leaving an airplane under all possible conditions of flight, and particularly for emergency jumps, are not advisable. It has been observed, however, that many jumpers, when leaving an airplane head-first, draw up their legs, which invariably causes a rapid "somersaulting" of the body before the parachute can be released. This often results in the release of the parachute at an instant that it is underneath the wearer. When thus released, one or more suspension lines are occasionally drawn violently over the inflating canopy, resulting in frictional burning of the silk.

c. The ripcord must never be pulled until the jumper is free of the aircraft. Failure to observe this fundamental requirement results in the parachute fouling on the airplane, with resultant hazard not only to the individual, but also the aircraft and remaining occupants. When free of the aircraft, immediately after jumping, the ripcord grip should be firmly grasped and pulled with a quick jerk, pulling the ripcord entirely free from its housing. A quick jerk facilitates complete release more effectively than a slow steady pull.

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d. As soon as the parachute has opened following a jump, the suspension lines should be observed for any twists. If twisted, they should be immediately pulled into their proper positions. During the descent the jumper should attempt to face the direction of the drift. He should also observe closely his distance from the ground, so as to be prepared to absorb the landing shock with his legs partly flexed. Landing in a rigid standing posture, or with the back toward the direction of drift, should never be attempted. Practice or training jumps are made only with the type T training parachutes, and under the condition outlined in AR 95–15. Such jumps are made in not more than a 10-mile wind and at not less than an altitude of 1,500 feet. The standard circular parachute is not maneuverable and little is accomplished by trying to guide it in any direction.

e. When training or practice jumps are contemplated in the vicinity of bodies of water the jumper should wear a standard life preserver vest and adequate provision for water rescue must be made before the flight is begun. If, after jumping, it is seen that a landing is going to be made in a body of water, the jumper should settle well back in the harness and unfasten the leg straps. When nearing the water the breast strap should be unfastened and the arms removed from the shoulder straps. When three or four feet from the water the jumper should drop out of the harness. The danger of the canopy falling on the jumper is thus removed since the drift carries it beyond. When landing in a high wind the jumper upon striking the ground should attempt to run forward towards the parachute and cause it to collapse, preventing his being dragged. Under such conditions holding back on the inflated parachute only tends to increase its pull.

f. When handling parachutes, the following precautionary measures will greatly prolong their life.

(1) Never pick a parachute up by the riser webs where they enter the pack.

(2) Never carry a parachute by the rip cord grip.

(3) Never lay the parachute down with pack next to the ground.

(4) Never leave the parachute where it is liable to come in contact with acid, oil, or grease.

(5) Never attempt to adjust the parachute harness in any way except the regulation of leg straps.

(6) Never tamper with the rip cord seal.

(7) Never pull the rip cord before leaving the airplane in the case of an emergency jump.

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(8) Never delay the opening of the parachute in the event of an emergency jump.

(9) Never use a parachute which has the seal broken or has in any way been tampered with. Turn it in to the parachute department for check.

(10) Never remove the rip cord grip from the pocket until it is to be used.

(11) Never tamper with the W. D., A. C. Form No. 58 in the pocket on the pack carrier.

(12) Never place a parachute in a locker while damp. Turn it in for check by the parachute department.

(13) Never wear a parachute in flight without having it properly fastened.

(14) Never allow the parachute harness or any part of the pack to catch on an airplane while entering or leaving.

(15) Never allow the rip cord protector flap to be opened while wearing a parachute.

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Appendix

BIBLIOGRAPHY

Figures 3, 6, 7, and 16. Courtesy of United-Carr Fastener Corporation, Cambridge, Mass.

Figures 4, 5, 44 to 48, incl., and 50. Courtesy of Talon, Inc., Meadville, Pa.

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[A. G. 062.11 (10–17–40).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

E. S. ADAMS,
Major General,
The Adjutant General.

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